Agriculture
and Rural
Economy
Division

Computable General Equilibrium Modeling of Agricultural Policies

Documentation of the 30-Sector FPGE GAMS Model of the United States

Maureen Kilkenny

It's Easy To Order Another Copy!

Just dial 1-800-999-6779. Toll free in the United States and Canada. Other areas, please call 1-301-725-7937.

Ask for *Computable General Equilibrium Modeling of Agricultural Policies: Documentation of the 30-Sector FPGE GAMS Model of the United States* (AGES 9125).

The cost is $11.00 per copy. Please add 25 percent extra for postage to non-U.S. addresses (including Canada). Charge your purchase to your VISA or MasterCard, or we can bill you. Or send a check or purchase order (made payable to ERS-NASS) to:

ERS-NASS
P.O. Box 1608
Rockville, MD 20849-1608.

We'll fill your order by first-class mail.

Computable General Equilibrium Modeling of Agricultural Policies: Documentation of the 30-Sector FPGE GAMS Model of the United States. By Maureen Kilkenny. Agriculture and Rural Economy Division, Economic Research Service, U.S. Department of Agriculture. Staff Report No. AGES 9125.

Abstract

This paper explains how U.S. agricultural policies are modeled in the 30-sector computable general equilibrium (CGE) model of the United States called the FPGE GAMS model (Farm Policy in General Equilibrium, General Algebraic Modeling System). The main features of the FPGE GAMS model are (1) farm programs are modeled explicitly rather than by using *ad valorem* equivalents; (2) every dollar spent and received under farm programs is accounted for; and (3) the facts that farm households earn nonfarm income and nonfarm households own farmland is made explicit. Policy modeling issues are discussed. There is a detailed explanation of the equations representing farm programs, spending, and program effects. Data sources and methods of calibration and parameterization are explained. A social accounting matrix (SAM) of the United States highlighting farm program expenditures and receipts is included.

Keywords: Farm programs, agricultural policy, computable general equilibrium (CGE), U.S. economy, modeling, GAMS.

The Author

The author is an assistant professor, Department of Economics, Pennsylvania State University. The fundamental structure of the model was developed while she was an economist in the National Aggregate Analysis Section, National Economics and History Branch, Agriculture and Rural Economy Division, Economic Research Service, U.S. Department of Agriculture.

Acknowledgments

A number of people contributed to the development and the documentation of the FPGE CGE model of the United States. Financial support for the development of the FPGE model was provided by cooperative agreement #58-3AEN-8-00127. Sherman Robinson provided a basic CGE model of the United States and collaborated on loan, stocking, and deficiency payment program modeling. Kenneth Hanson provided the nonfarm economy data and parameter sets. Andy Bernat, Kenneth Hanson, Bradley McDonald, Frederick Nelson, J. Michael Price, and Gerald Schluter suggested many improvements for the documentation.

1301 New York Avenue, NW
Washington, DC 20005-4788

June 1991

Contents

Computable General Equilibrium Modeling of Agricultural Policies

Documentation of the 30-Sector FPGE GAMS Model of the United States

Maureen Kilkenny

Introduction

This paper describes how agricultural policy is modeled in the economywide computable general equilibrium (CGE) model of the United States called the FPGE-CGE Model (Farm Policy in General Equilibrium). The FPGE-CGE model has been developed to analyze the economywide effects of changes in farm policies. Economists have long known that even sector-specific policies have multi-faceted economywide effects (see, for example, Bhagwati and Srinivasan, 1973). When a sector in a fully employed economy is subsidized, mobile productive resources are drawn into the sector from other sectors. If factors are not mobile, an increase in the incomes of households supplying factors to the subsidized sector may be the main initial effect. In either case, economic activity upstream and downstream as well as the pattern and level of international trade change. These changes induce secondary adjustments in the sectoral pattern of economic activity, employment, and the distribution of income. Thus, an economywide model is needed to analyze the extra-sectoral effects of changes in sector-specific policies or conditions.

The FPGE-CGE model is the second generation of the basic 10-sector ERS/USDA CGE model of the United States. The ERS/USDA parent model is documented in Robinson, Kilkenny, and Hanson (1990). The derivative FPGE model is a 30-sector version rewritten explicitly for farm policy analysis. The documentation of the FPGE model concentrates on the differences between it and the basic ERS/USDA model: farm policy, farm program expenditure, and agricultural income distribution. Both documentation papers are required for a complete explanation of the FPGE model. Finally, both models will continue to be refined and improved, and thus will change from what they are at the time of this documentation.

In brief, the CGE model is a system of nonlinear simultaneous equations representing the constrained optimizing behavior of all agents as producers, consumers, factor suppliers, exporters, importers, taxpayers, savers, investors, or government. The model solves for levels of output, factor employment, wages, and prices by sector, trade and trade prices by commodity, income by household type, other nominal flows, and the macroeconomic aggregates for a specific year. A CGE model is best used to compare these variables under existing policies and conditions with what they may have been under different policies or conditions. The general equilibrium comparative static results from CGE models provide different (not necessarily better) as well as additional information from partial equilibrium or econometric models.

Activity levels, factor employment, prices, and income are all endogenous variables in the CGE model. The exogenous variables are technological and behavioral parameters, some factor supplies,

some foreign variables, and most policy instruments. This is an important difference between CGE simulation models and econometric parameter estimating models where levels, prices, and the other variables are independent and exogenous variables and the behavioral parameters (coefficients) are estimated. CGE modelers rely on behavioral parameters to find price and quantity results. Coefficient estimators rely on price and quantity data to find behavioral implications.

The FPGE-CGE model is a Walrasian CGE model, meaning that all markets must clear explicitly, including the market for which the market-clearing equation is dropped. This is one reason why Walrasian CGE simulation models differ from econometric simulation models. An econometric model becomes a simulation model (where prices and quantities are endogenous) when the econometrically estimated coefficients are treated as parameters and the system is closed, for example, with a market-clearing constraint. The relative strength of stochastic econometric models is that they include confidence intervals; results are further characterized by real world unexplained variability. In contrast, Walrasian CGE models are deterministic. Econometric models have known statistical properties; CGE models have known theoretical properties. Walras' Law cannot be strictly imposed on an econometric model. Repeated solution of a CGE model over ranges of parameter values can provide some sensitivity information, however, on CGE model results (Harrison and Vinod, 1990).

The nature of the behavioral parameters usually differs between Walrasian CGE models and econometric simulation models. The FPGE model parameters are directly and fundamentally structural; that is, not price elasticities. The supply side parameters directly represent technology and the demand side parameters represent preferences. Thus, CGE models are the natural heirs to the linear programming tradition in agricultural economics. The ERS/USDA CGE models are an advance over linear programming models at the minimum because prices are endogenous and functional forms are explicitly nonlinear. Not all CGE models, however, are explicitly nonlinear.

The FPGE model also differs from farm sector partial equilibrium and even multimarket simulation models because of its economywide scope. This has important implications for how realistically the model simulates the economywide effects of farm sector adjustments. Farming in the United States employs a very small portion of the economy's workforce and, thus, has little longrun effect on the opportunity cost of labor economywide; that is, it faces elastic longrun supplies of labor, and has little effect on economywide wage/rent ratios. In partial equilibrium models, one assumes exogenous inelastic or infinitely elastic off-farm labor, land, and capital supplies. Reality lies somewhere in between, and can be simulated using CGE models under different behavioral or closure assumptions. Thus, CGE models are particularly useful at identifying individual policies that are not sustainable because they may induce excessive output or capacity drawn into agriculture from other sectors.

Furthermore, from the economywide perspective, agriculture is a small sector but government spending to support farming has recently been large. Farm program spending contributes to the government deficit and either crowds out domestic investment or raises interest rates. A rise in interest rates may raise the value of the dollar and lead to current account deficits (capital account surpluses). By using CGE models, we have been able to show that the significant economywide effects of farm policy changes occur through the links between sectoral activity and government deficits, the trade balance, and investment (Kilkenny and Robinson, 1990b).

Our experience in modeling agriculture in an economywide context has suggested that accurately modeling farm program expenditure and factor supply are just as important as accurately representing technology or preferences. In fact, the specification of technology is less important as long as changes in farm sector activity do not affect economywide relative factor prices. For this reason, this paper focuses on the specification of farm policies and not on the specification of farm production technology. The FPGE policy specification can be used in CGE models with any production functional forms, from Cobb Douglas to Generalized McFadden, for example, as well as any forms of

consumer preferences. The first key issue in the choice of functional forms in the USDA-CGE models, where the nature of adjustment is likely to be movement to a new isoquant/indifference curve rather than along one, is homotheticity or the lack of it. The second key issue is the substitutability between farmland and other inputs, since farmland is immobile by definition and changes in acreage reduction provisions will induce movements along isoquants as well.

The FPGE model solution in the benchmark year matches the data on the U.S. economy as published in the *Survey of Current Business*. This match is guaranteed in part because one parameter in every behavioral equation and many policy parameters are calibrated. Briefly, calibration is the process of determining parameters so that the solution of the model exactly replicates the observations of the variables (and satisfies Walras' Law) in the benchmark year. The calibration of the basic structural parameters is explained in more detail in the basic model documentation (Robinson, Kilkenny, and Hanson, 1990). This paper focuses on calibrating farm policy parameters only.

The next section summarizes U.S. agricultural policies, problems that arise in modeling these policies, and some solutions to these problems. The body of the documentation covers the model equations for simulating the effect of farm policies on production, price, commodity stocking, and government expenditures. Those sections describe the equations, explain how farm program policy instruments are calibrated, and attempt to provide some intuition about how the FPGE model works.

A U.S. Social Accounting Matrix (SAM) for calendar year 1986 contains benchmark year data for the model. An aggregated version of the SAM (highlighting farm program expenditures and receipts) is presented and discussed in the last section.

Policy Modeling Issues

For documentation purposes, this model covers U.S. farm policies under the 1985 farm act as they operated in 1986. This year is chosen because 1986 is the most recent year for which enough verifiable data on the whole U.S. economy are available to calibrate the 1,300-plus equation FPGE model. Some key data are not even available yet for 1986; those data have been simulated by running the ERS/USDA 1982 benchmark year model. The 1985 farm act policies are spelled out in the Food Security Act of 1985, explained by Glaser (1986) and tabulated by Chattin and Nelson (1988). A comprehensive report of program provisions is provided by Green (1990). Ex post reports of farm program spending are summarized and reported in the *Survey of Current Business*.

Many aspects of the 1985 farm programs are common to previous programs, and many will be continued in future farm programs. The United States employs a variety of farm policies, including the types of policies practiced by other countries. Thus, a model of U.S. farm programs provides a useful point of departure for models of future U.S. farm programs as well as models of farm policies in other countries.

A summary of the major U.S. farm programs is presented in table 1. The domestic farm programs have three primary components: farm income support through deficiency payments, excess supply control through acreage reductions, and farm cash-flow stabilization through the nonrecourse loan and purchase program. The two types of trade policies are quotas-cum-tariffs and export subsidies. They provide protection from foreign competition that may interfere with the domestic programs. The domestic and trade programs together have major, often offsetting, effects on agricultural output and trade.

Table 1--Summary of major U.S. agricultural support programs

Program	Objective	Instrument(s)	Main incidence
Deficiency payment	Support farm income	Target price	Raise returns to factors in agriculture, increase government expenditure
Acreage restrictions	Reduce farm surpluses	Reduction rate	Reduce output or induce factor substitution, contain government expenditures
Nonrecourse loan	Support market price Subsidize farm credit	Stock accumulation Loan rate	Stabilize market price, increase factor returns and government expenditures
Import quotas	Support domestic price	Quota	Raise price of importables, reduce imports, generate rents, increase domestic output
Export subsidies	Maintain export market share	Subsidies on exports	Increase exports, reduce stocks

Ad Valorem vs Explicit Modeling

The first challenge in modeling agricultural policies is to find the best way to represent the policy instruments. One way to model farm programs is to use *ad valorem* producer subsidy equivalents called PSE's (USDA, 1989b). The *ad valorem* aggregate PSE rate per commodity is calculated as the ratio of farmer receipts, including farm program benefits, relative to market receipts. The exogenous PSE rate can enter the model as a proportional markup over the market price received by the producers of the supported commodities. The *ad valorem* PSE modeling approach, however, is problematic and may generate distorted simulation results. The aggregate PSE measures were not designed to provide estimates of the policy instruments that give rise to the support. They were designed to serve as an aggregate measure of support (IATRC, 1990).

The problem with using *ad valorem* equivalents is that agricultural subsidies are rarely provided as *ad valorem* markups. The first distortion incurred by using the *ad valorem* approach is that an exogenously specified PSE rate does not vary with changes in the market price as do deficiency payments and loan forfeit benefits. With respect to changes in economic conditions, the simulated producer behavior as well as government spending on farm programs are incorrect when fixed equivalents are used (Kilkenny and Robinson, 1989). If producer behavior with respect to output and land use is not correct, the model loses credibility as an indicator of farm sector adjustments. Nevertheless, because agriculture is relatively small in an economywide context, one could assume that the economywide results are valid. That is a tenuous assumption. If simulated farm program spending is incorrect, the economywide effects probably are too. This follows because the most important links between U.S. agriculture and the rest of the economy, as noted earlier, are budgetary and macroeconomic.

Through the government budget deficit, farm program spending affects gross saving and, therefore, net investment. A major reduction in farm program spending could imply a change in the macroeconomic composition of final demand from consumption to investment or trade. This is because the bulk of farm program spending is on income support for farm households, and the bulk of household income is spent on consumption. The farm program deficit spending by the government either crowds out investment or induces capital inflows through its effect on interest rates. In any case, a change in the macroeconomic pattern of demand between consumption, investment, and/or net

exports requires a change in the sectoral pattern of supply. This is the budgetary and macroeconomic link between agricultural policies and nonagricultural economic activity. Previous research has indicated that the link is indeed important, and that model simulation results are sensitive to the mode of policy specification (Kilkenny and Robinson, 1990a).

Agriculture is a relatively small part of the U.S. economy, accounting for 2.3 percent of the real gross domestic product in 1986. In contrast, agriculture has recently been a large recipient of government transfers. In 1986, the $31.4 billion spent on farm trade, income, and price support programs equaled nearly a fifth of the $144.1 billion combined State and Federal government deficit. That year, the combined government deficit ate up a fifth of $669.5 billion gross private savings. From another perspective, households that supply factors of production to agriculture receive a disproportionately large amount of income support. In 1986, $11.8 billion was spent on farm income support, compared with $17.8 billion spent on unemployment compensation for the nonfarm 97.8 percent of the working population (OMB, 1990). Changes in overall spending on agriculture can be expected to affect the sectoral allocation of factors and economic activity because of its large budgetary and relative incentive effects. It is, thus, imperative to correctly account for this spending from both the expenditure and receipt sides of the transaction.

Domestic agricultural and trade policies interfere with the U.S. ability to enjoy its absolute advantages in grain production as comparative advantages. The United States and many countries use nontariff trade barriers such as quotas to protect certain domestic farm sectors. The quota modeling problem parallels the problem with PSE's for domestic subsidies (Kilkenny and Robinson, 1989). Nontariff instruments can only be locally approximated by a tariff equivalent. The protection simulated by a parametric tariff equivalent does not vary inversely to changes in world prices the way protection rates would vary under a quota.

Another problem with the use of an aggregate measure of support such as the *ad valorem* PSE as the policy instrument in a model is the assumption of common participation rates in the income, loan, and stocking programs. In reality, participation rates vary across programs by crop. For example, many wheat producers may participate to receive deficiency payments, but the proportion of wheat production that is crop collateral under the loan program and the wheat actually forfeited to the Commodity Credit Corporation (CCC) can be different proportions of total wheat output. The different programs affect net returns differently, depending on whether they subsidize output, inputs, or otherwise. The variation in participation rates across programs (not to mention as policies change) is an important topic deserving continued attention.

Our fundamental approach to the policy modeling problem is to explicity represent farm policy instruments. Explicit representation means that the policies are modeled as closely as possible as they really work. For example, the target price is an exogenous parameter. The deficiency payment output subsidy is then determined endogenously in the model as the shortfall between the market and target price. If the market price rises, the deficiency payment falls. Payment rates thus vary inversely with respect to market prices. With respect to participation rates, the FPGE model introduces distinct participation rates for deficiency payments, loan collateral, and loan forfeits. These rates can be updated exogenously or determined endogenously if the appropriate equations are added to the FPGE model.

Import quotas are modeled explicitly as absolute restrictions on imports. The model simulates how domestic prices and quota rents vary with changes in world prices or excess domestic demand rather than allowing changes in imports. In all, 11 farm programs that affect the farm producer's resource allocation decisions or trade are modeled explicitly in the FPGE model (table 2). Programs that do not signal changes in production or trade are modeled as providing lump-sum budgetary outlays to

Table 2--Programs modeled explicitly

Program	Target sectors
Direct income support:	
Deficiency payments	Cotton, food grains, feed crops
Input policies:	
Acreage reduction	Cotton, food grains, feed crops
Assessments	Dairy
Input subsidies	All crops
Market price support:	
Commodity loans	Cotton, food grains, feed crops, oil crops, sugar, other agriculture
Loan forfeit benefits	Cotton, food grains, feed crops, oil crops
Inventory accumulation	Food grains, feed crops, oil crops, cotton, dairy products
Import quotas	Cotton, oil crops, sugar, dairy products, processed sugar
Tariffs	Livestock, oil crops, sugar, meat processing, other
Export promotion:	
Marketing loans	Cotton, food grains, feed crops, oil crops
Export enhancement	Livestock, food grains, feed crops, grain, meat, and oil processing
Taxation	All agricultural sectors

households. A complete accounting is made of all program expenditures by Federal and State governments on farm and related programs.

The explicit approach, even without endogenous participation specification, is useful for modeling how changes in the rest of the United States or world economy affect U.S. agriculture, and for comparing among complete liberalization scenarios and complete liberalization projections. For comparisons of different policy mixes, partial liberalization, or projections under changing farm programs, participation rates should be endogenized or updated.

Aggregation

Aggregated CGE models have been useful for farm policy analysis when the focus is on the nonfarm economy. The Organization for Economic Cooperation and Development (OECD) developed and applied a set of 13-sector, single-country models to quantify the effects of agricultural policies (Burniaux and others, 1988). For the United States, see Robinson, Kilkenny, and Adelman's (1989) application of the 10-sector USDA/ERS model. Agricultural policy representation in these relatively aggregated models is necessarily abstract. Less aggregation is required for more detailed policy representations.

The optimal degree of aggregation is detailed enough to avoid biased results, but broad enough to provide significant results. We avoid modeling extremely small sectors for at least two reasons. First, complete disaggregation is inappropriate in an economywide general equilibrium model. The economywide comparative static results of changes in policies affecting the small sectors will be imperceptibly different from zero, that is, insignificant. By the same token, the small sector results

may be overstated. Second, wide variations in scale in a model may result in an ill-conditioned mathematical programming problem to which there is no solution.

The 30-sector FPGE model has disaggregated farming into eight sectors. The FPGE farm program policy specification can also be applied in more or less disaggregated models. However, the more disaggregated farm sectors are, the easier it is to calibrate the model. But, the more aggregated the model, the more difficult it is. The difficulties arise for aggregated models because parameters must be constructed as weighted averages of single-sector parameters.

Primary production agriculture accounts for less than 3 percent of the economic activity, employment, and income in the United States. Disaggregated primary agriculture plus food processing comprise 16 of the 30 sectors in this model. Some of these sectors employ less than a hundredth of 1 percent of the labor force. For this and other reasons, the 30-sector FPGE model is badly scaled. It is not ill-conditioned, however, and does solve if carefully calibrated. Small imbalances in base year data render the 30-sector model insolvable. This imposes a very strict discipline on the modelers to always observe Walras' Law.

Sectors

The 30-sector model aggregation was chosen for trade and agricultural policy analysis. Primary agriculture and processing are relatively disaggregated. The other sectors are aggregated according to import penetration or export orientation. This aggregation is shown in table 3.

Agricultural activities are aggregated into sectors according to similarity in farm programs, similarities in demand, and similarities in the mobility of resources among the activities within the sectors. For example, the feed crop (FEEDCRP) sector is the aggregate of corn, oats, barley, sorghum, alfalfa, straw, hay, and pasture. Programs are similar for corn, oats, barley, and sorghum. There are no programs, however, for pasture crops. Policy instruments must be calibrated as weighted averages of the instruments or lack thereof across the crops in each sector. The feed crop producers also face similarities in demand in that each is an intermediate product. Finally, primary factor inputs are largely mobile across the feed crops. Machinery and cropland are commonly rotated among corn, oats, and alfalfa.

The dairy and sugar production and processing sectors are also disaggregated from other processing sectors. This is done so that the quota restrictions on these products can be represented cleanly as limits on sugar and dairy product imports, without also implicitly limiting other imports that may otherwise be aggregated together with those processed foods. Furthermore, the artificial scarcity induced by the quotas raises demand for the domestic input into the processing sectors. This effect is more obvious in a model that disaggregates milk and beet and cane sugar production from other production activities.

Households

The FPGE model has a simple but useful household aggregation scheme based on functional and size income distribution. Four types of households are distinguished: a farm household and three nonfarm households classified by income strata. Institutional accounts are used to distribute farm and nonfarm functional income across the four household types as shown in table 4. This is the basis of the GAMS table SINTYH in the FPGE GAMS model (Appendix I). In the model, the income mapping shown in table 4 is expressed as shares of each type of income to each type of household.

Households that supply farm labor are classified as "farm households." As such, 100 percent of after-tax farm labor income goes to the "farm" household. Farm households receive most of the

Table 3--Sector/commodity aggregation

1	DAIRY	Milk
2	LVSTK	Poultry, eggs, cattle, swine, sheep
3	COTTON	Cotton: raw, lint, and seed
4	FOODGRN	Wheat, rice, rye
5	FEEDCRP	Corn, oats, barley, sorghum, hay, alfalfa, pasture
6	OILCROP	Soybeans, peanuts, flax, safflower, sunflower
7	SUGAR	Beets and cane
8	OTHCROP	Tobacco, fruit, vegetables, nuts, farm forest, greenhouse and nursery products, farm products-nec.
9	MEATMNF	Meat and poultry processing
10	DAIRYMN	Milk, butter, cheese, ice cream processing
11	GRNMILL	Flour and grain milling, breakfast cereals, rice milling, bread and cake, macaroni/pasta
12	FEEDMNF	Prepared animal feeds
13	CORNMIL	Wet corn milling
14	SUGARMN	Sugar refining
15	SOYMILL	Cotton, soy, vegetable, and animal oil milling, shortening and cooking oils
16	MISCFOO	Canned, dried, pickled, or frozen foods, confectionery, chocolate, coffee roasting
17	PRIMRES	Forestry, fisheries; iron, metal, coal, stone mining
18	PETRO	Gas and oil extraction and refining
19	CONSTRU	New construction and maintenance
20	CHEM-RU	Fertilizer, pesticide, plastics, drugs, paints, rubber
21	OTHNDUR	Tobacco, yarns, textiles, apparel, leather, footwear
22	OTHDURM	Lumber, wood, household furniture, glass, stone and clay products, jewelry, toys, manufactures-nec.
23	METALMN	Iron, steel, metal fabricated and stamped products
24	MACHINR	Ordnance; engines, farm machinery, construction and mining machinery, industrial machinery (nonelectric)
25	OTH-ELE	Office machines, computers, scientific and other instruments, lighting, telephone, and electronic tubes
26	CON-ELE	Accounting machines, typewriters, appliances, radios, phonographs, semi-conductors
27	TRNS-EQ	Cars, trucks, buses, trains, aircraft, boats
28	TRD-TRN	Highway, waterway, railroad, air transport services; warehousing, pipelines, travel agencies; wholesale and retail trade
29	FINANCE	Owner-occupied dwellings and real estate
30	SERVICE	Ag, forestry, and fishery services; communications, radio and TV broadcasting, utilities, personal and business services, restaurants, repair services, entertainment, health and education, Federal and State government, noncomparable imports

after-tax farmland and capital-related shares of farm sector value-added. Many farm households also earn some off-farm salary income (Ahearn, 1986; Brooks and Reimund, 1989). They earn off-farm capital income too. It is assumed that the portion of farm household income coming from off-farm capital and transfers is the same as the average share in nonmetro household income (Bentley, 1988). Because off-farm income provides almost half of farm household income, it is an important stabilizing factor. This feature is another unique advantage of CGE models which can explicitly include the nonfarm economy and nonfarm income opportunities.

Nonfarm households are classified as poor if in the lowest 20 percentiles of nonfarm income, median if in the middle 60 percentiles, and wealthy if in the upper 20 percentiles (U.S. Dept. of Commerce, 1984, 1989). Nonfarm household income arises largely from wages and salaries in nonfarm occupations, returns to nonfarm capital, and transfers. Nonfarm households also earn some income from their ownership of farmland. Farmland income is distributed in the FPGE model across

Table 4--Distribution of functional income to households, 1986

Household type	Farm			Nonfarm				Total
	Labor	Capital	Land	Labor	Capital	Remits	Trans	
				Billion dollars				
Farm	27.75	8.31	11.81	28.65	8.90	0	7.45	92.87
Poor			1.26	141.07	124.55	-0.38	158.48	424.99
Median			.94	850.81	199.83	-.66	207.17	1,258.09
Wealthy			1.73	1,183.65	351.07	-.85	123.70	1,659.30
Total	27.75	8.31	15.74	2,204.18	684.35	-1.90	496.80	3,435.25

Notes: Nonfarm labor income is salaries and wages from nonfarm sectors and government. Remits are net remittances to (-) or from (+) abroad. Trans are transfers to households including social security, retirement, unemployment compensation, and veterans benefits.

households according to the proportions of farmland owned by households in value terms (Boxley, 1985). Some of the farmland rental income is also distributed to nonfarm households through value-added in the real estate sector (FINANCE). Again, the explicit inclusion of nonfarm agents in the CGE model is an important feature. Subsidies provide rents to the owners of the relatively fixed factor of production, in this case land. The household aggregation scheme displayed here provides a simple first-cut approach to tracing those rents through the economy.

Farm Program Modeling

This is the main documentation section of the paper. It details how policy instruments are defined and enter the FPGE model. Because many farm programs are interdependent, they are discussed in groups. The first group is domestic policies: deficiency payments, acreage set-asides, stocking, and the loan programs. The second group covers trade policies: export enhancement programs, tariffs, and quotas. The third discusses programs specific to the dairy sector. Finally, the special tax treatment of agriculture is covered. This text presents an algebraic representation of the FPGE model. The corresponding GAMS code is provided in Appendix I. A glossary of terms can also be found in the GAMS code of Appendix I. This is because the first part of a GAMS program is the declaration and definition of parameters and variables. The GAMS modeling code is self-documenting.

As a point of departure, consider the basic model of producer behavior. How do prices (and policies) drive output supply and input demand? The equations representing producer behavior are the single-output, aggregate production functions and the first-order conditions for profit maximization by the sector. Levels of primary factor demand by each sector for primary factors labor (L), capital (K), and, in crop sectors, land (T) are chosen to maximize net revenue from production subject to the specified production technology $x_i(L_i,K_i,T_i)$. The production technology $x_i(\cdot)$ may be expressed in a variety of forms, including Cobb-Douglas, Constant Elasticity of Substitution, or Generalized McFadden.

The FPGE model documented here uses a Cobb-Douglas function for the primary factors and the popular nested specification for intermediate good use in production. First, combine primary factors (L,K,T) to produce output of the ith commodity (XD_i):

(1) $$XD_i = x_i(L_i,K_i,T_i)$$

Second, demand for intermediate inputs is a derived demand. Intermediate inputs (fertilizer, chemicals, feeds, and others) are combined in a fixed-coefficient bundle used per unit of gross output (XD_j). The coefficient ($IO_{i,j}$) gives the amount of input i required to produce one unit output of good j. Thus, the demand for the ith good as an intermediate good is given by the sum use in all sectors:

$$(2) \qquad INT_i = \Sigma_j IO_{i,j} \cdot XD_j$$

The value distributed to the primary factor suppliers of an additional unit of output is the value-added price (PVA_i). It is the producer price per unit (PX_i) net of *ad valorem* indirect business taxes ($ITAX_i$), net of the cost of the intermediate good bundle ($\Sigma_j IO_{j,i} \cdot P_j$), and gross of any distorting subsidies (PIE_i):

$$(3) \qquad PVA_i = PX_i \cdot (1\text{-}ITAX_i) - (\Sigma_j IO_{j,i} \cdot P_j) + PIE_i$$

The value-added price per unit times output is marginal revenue net of intermediate costs. Net revenue after payments to primary factors is profit per unit. Since all value-added is distributed entirely to the primary factors of production, the economic profit per unit is always zero. The first-order conditions for the profit maximum (or cost minimum) state that the marginal value product of a factor minus that factor's price equals zero. Given diminishing marginal returns, the demand by a sector for a primary factor is positive with respect to PVA_i and negative with respect to factor price.

Farm programs that raise value-added increase agriculture's demands to employ mobile capital, labor, or land. If these primary factors are not mobile, farm programs simply bid up their factor prices. All programs that affect value-added are ultimately reflected in PVA_i in the FPGE model. There are four ways to raise PVA_i: (1) increase PX_i due to a policy that increases final demand (consumption, stocks, or net exports), (2) decrease indirect tax rates $ITAX_i$. (3) lower the price of intermediate goods by input subsidy, and (4) increase producer subsidies PIE_i. The PIE_i represent producer incentive equivalents as defined by Rausser and Wright (1987). In the FPGE model, a PIE_i is an endogenous specific (dollars per unit) subsidy. It is the sum of the deficiency and loan forfeit benefits net of assessments per unit of output.

Programs which restrict primary factor supply raise factor prices and reduce output, *ceteris paribus*. All such programs are modeled directly as restrictions on factor supplies.

The following sections focus on the specification of the endogenous components of PIE, on factor supply restrictions, and on how stocking and trade policies affect final demand and market prices.

Domestic Policies

The policies discussed in this section maintain farm income, support domestic producer prices, and control supply. A good summary explanation of the recent income and price support programs is provided by Evans and Price (1989). A glossary of terms as used by policymakers is provided by Lipton and Pollack (1989). The definition of recently coined terms for the measurement of policy transfers is provided by Chattin and Nelson (1988) and Webb, Lopez, and Penn (1990).

Deficiency Payments

Deficiency payments are intended to provide income support without affecting resource allocation. In reality, deficiency payments do appear to induce resource allocation in agriculture (Houck and others, 1976; Kramer and Pope, 1981; Perry and others, 1989). If deficiency payments are completely decoupled (unrelated to economywide resource allocation decisions), they should be excluded from the

producer incentive equivalent (PIE_i) and modeled as direct, nondistorting income transfers.[1] One way to model relatively coupled deficiency payments is presented below.

Deficiency payments are made to participating producers if the market price falls below a policy-prescribed target price. Thus, the deficiency payment policy instrument is the target price. The payment rate equals the difference between the target price and the national weighted average market price received by farmers or the announced loan rate, whichever is higher.

When farmers growing wheat, corn, oats, grain sorghum, barley, cotton, or rice (program crops) participate in the farm programs, they receive the deficiency payment rate per unit of program output (XP_i). The deficiency payments received by the Nation's producers of commodity i ($DEFPAY_i$) is national program output times the excess of the parametric target price (TP_i) over the loan repayment rate (PL_i) or the variable producer price (PX_i), whichever is higher:

$$
(4) \qquad \begin{aligned}
DEFPAY_i &= XP_i \cdot (TP_i - PL_i) && \text{if } PL_i \geq PX_i \\
DEFPAY_i &= XP_i \cdot (TP_i - PX_i) && \text{if } PL_i < PX_i \\
DEFPAY_i &= 0 && \text{if } PX_i \geq TP_i
\end{aligned}
$$

Deficiency payments are made in cash and in kind. The in-kind payments are certificates (titles) to commodities acquired by the Commodity Credit Corporation under the loan program. Since certificates are transferrable, they are ultimately equivalent to cash income. Therefore, no distinction is made in this model between the two forms of payments to participating farmers.

The target price instrument in the FPGE model must be calibrated. First, since base year market prices are normalized to unity, published target prices must also be normalized with respect to those prices. Furthermore, some aggregation of target prices and deficiency payments across program and nonprogram crops in a modeled sector is required. Both of these operations are accomplished in a calibration program called FARMDATA.GMS (for personal computers) or FARMDATA GAMS (for mainframe computers). FARMDATA.* is presented in Appendix II.

The TP_i is calibrated to reproduce the data on actual deficiency payments made. Published data for all program crop sectors on nominal prices, production, target prices, loan rates, deficiency payments, and loan program transactions are required to calibrate each TP.[2] The data on nominal prices and production are used first to create value weights for aggregations. Next, published target prices and actual loan rates are used to deduce deficiency payment program participation rates (detailed immediately below). Then, the loan program data is used to calibrate the base year loan rate (PL^0_i) to reconcile with observed loan transactions (explained in the next section). Finally, the target price in the base year (TP^0_i) is calibrated so that equation 4 replicates actual deficiency payments in the base

---

[1]For a discussion of distorting types of domestic farm policies, see Mageira and others (1990).

[2]Good data on deficiency payments by sector and calendar year can be found in the summary reports on PSE's such as Chattin and Nelson (1988) or Webb, Lopez, and Penn (1990). A regularly published source is *Economic Indicators of the Farm Sector* (USDA, any year). Annual payment data by sector are first used to construct shares of total deficiency payments, then reconciled with data on aggregate deficiency payments reported by the Bureau of Economic Analysis in the *Survey of Current Business*, table 3.19; July issue of any year.

Alternative sources of data on deficiency payments may be obtained by a careful interpretation of the data presented in *Agricultural Statistics*, or issues of *Agricultural Outlook*, table 37 "CCC Net Outlays by Commodity and Function," or *History of Budgetary Expenditures of the Commodity Credit Corporation* (USDA, any year) Note that many of these data are tabulated on a fiscal year basis, while the CGE model is tabulated on a calendar year basis. Crop year data are more likely to coincide with calendar year information than fiscal year information.

year ($DEFPAY^0_i$); that is, the target price is calibrated to exceed the loan rate (or market price) by the deficiency payment per unit of program output.

This gives the target price policy instrument for the benchmark year so that all expenditures are accounted for as income and the system modeled satisfies Walras' Law. For simulations of other years, the TP and PL parameters must be updated outside the FPGE model. There are at least two ways to update policy instrument parameters. One, simply normalize the published policy parameters with respect to TP^0 and PL^0. For example, under the unamended 1985 farm act, the loan rate should be 75-85 percent of the past 5-year market prices. The parameter PL written into the model for a subsequent year can be calculated accordingly. Two (for interpolations), the calibration program FARMDATA can be run directly on the data for the intervening years to normalize the instruments relative to the base year prices. The FARMDATA program is written with a dynamic set specification to facilitate this procedure.

A key element in determining actual deficiency payments is participation. Likewise, the participation parameter is key in calibrating the target price. Here is how participation rates and program output parameters are calibrated. The levels of program output in the base year (XP_i^o) are calibrated to reconcile actual payments made with the actual deficiency payment rates in each sector. Deficiency payments are defined in equation 4. If there was 100-percent program participation and if program yield is the average yield, then $XP_i = XD_i$ and the deficiency payments made would equal:

$$DEFPAY_i = XD_i \cdot (TP_i - PL_i) \qquad \text{if } PL_i \geq PX_i$$
$$DEFPAY_i = XD_i \cdot (TP_i - PX_i) \qquad \text{if } PL_i < PX_i$$

where the difference between the above and equation 4 is that potential payments are made on total output (XD_i) rather than a participating portion (XP_i).[3] When the program participation rate (XPR_i, where $XPR_i = XP_i/XD_i$) equals 1, the two calculations of $DEFPAY_i$ are equivalent. This gives us a clue to the true XPR_i. It is found as the ratio of the two calculations of $DEFPAY_i$. Since participation is not universal, there are payment limitations, yields differ, and current output is not exactly the basis for payment; the ratio of actual to potential deficiency payments is less than one. This ratio is interpreted as the benchmark year participation rate (XPR^0_i):

$$\frac{XP^0_i \cdot (TP^0_i - PL^0_i)}{XD^0_i \cdot (TP^0_i - PL^0_i)} = XPR^0_i$$

where the data on deficiency payments made are used directly in the numerator, and the denominator is calculated using TP^0_i and PL^0_i as published (not calibrated). (Note: if $PL^o_i < PX^o_i$, the denominator would obviously be $XD^o_i \cdot (TP^o_i - PX^o_i)$.)

Since participation is a decision based on variables such as expected future prices that are exogenous to the annual CGE model, the XPR_i may be left as exogenous parameters. Comparative static exercises must then be interpreted given the participation rate. This form of the FPGE model is useful mainly for full liberalization experiments. To project the effect of changes in the rate of farm subsidization, the XPR_i must be endogenized or updated in some way. One way to update the XPR_i is to rely on an econometric model that can simulate program output (XP_i) such as FAPSIM (Salathe and others, 1982). Another way is to assume rational expectations and to add participation decision

[3]Here program output and participating output are taken as equivalent, assuming a completely coupled policy. If the policy is completely decoupled, program output (XP) is exogenous. If there is a parametric relationship between participating and program output, the relationship can be written into the model.

equations to endogenously determine participation rates (Kilkenny, 1991). The question is what differs among producers so that some find it optimal to participate and others find it optimal not to.

Whether the XPR_i are endogenous or exogenous, national program output (XP_i) is defined as:

(5) $XP_i = XPR_i \cdot XD_i$.

Acreage Reduction

To compensate for the output-inducing effects of the support programs, farm acts since 1933 have included provisions that constrain primary factor use. The Secretary of Agriculture has the authority to require acreage limitations, set-asides, or paid land diversion programs if total supplies of program crops may be excessive. Producers must comply with the acreage restrictions to be eligible for deficiency payments, loan programs, and other payments.

All acreage reduction programs are modeled as a unified restriction on the participants' cropland in program commodities by sector. The policy instrument is the acreage reduction percentage by crop (ARP_i). ARP_i is the proportion of program participant land (LP_i) barred from production under all programs in effect for each crop. This is a simple, abstract way to impose acreage reduction programs in a model without imposing the restrictions on nonparticipants. This paper focuses on the policy specification, not the model of land use. More detailed models of agricultural land use and land markets are by Whalley and Wigle (1988), Hertel and Tsigas (1988), and McDonald (1990).

The supply of land for production of crop i ($FS_{i,LAND}$) is constrained by the total land supply available ($FS^o_{i,LAND}$) minus the acreage that is set aside by participants complying with acreage reduction restrictions:

(6) $FS_{i,LAND} = FS^o_{i,LAND} - ARP_i \cdot LP_i$

The higher the set-aside rates, the lower is the supply of harvestable program cropland, as long as participation rates remain fixed. Likewise, the higher the amount of participating land, the lower the supply of total available cropland. If yields are identical between participants and nonparticipants, the participants' supply of productive cropland is:

(7) $LP_i \cdot (1-ARP_i) = XPR_i \cdot FS_{i,LAND}$

The demand for land in sector i ($FD_{i,LAND}$) is determined according to the first-order conditions for profit maximization. Returns to land are determined at the rate at which the amount of land supplied equals the amount demanded.

Any direct payments that are made to compensate farmers for conservation reserve and other provisions not listed in table 2 are grossed into an aggregate measure of decoupled payments called DIRPAY. The DIRPAY are credited from the CCC to owners of claims on land factor income.

Loan and Stocking Programs

While the deficiency payment scheme supports farm income, the loan program supports producer market prices and smoothes cash-flow over the crop year. There are three main types of incidence of the loan and stocking programs. First, stock accumulation supports market prices. This aspect provides benefits to program participants and nonparticipants alike. Second is the nonrecourse loan program's loan forfeit benefit. Third is the reduced interest expense or loan subsidy benefit.

There are also two variants of the nonrecourse loan program that can easily be modeled but are not explicit in the version of FPGE GAMS in Appendix I. One is the farmer-owned reserve, in which farmers are compensated but hold their own stocks; the other is the marketing loan program, which helps maintain U.S. export competitiveness by lowering loan repayment rates to world price levels. Discussion of the marketing loan program is postponed to the section on trade policies.

Price Support via Stocking

Under the loan program, a farmer pledges his crop as collateral for a loan from the CCC. The value of a farmer's crop collateral is calculated at the loan rate price. If the market price is not sufficiently attractive by the time the loan is due, the farmer may forfeit all or part of the pledged crop in lieu of repaying all or part of the loan. The CCC has "no recourse" but to accept the commodities as stocks and retire the repaid loan.

Thus when market prices might otherwise be low, the CCC acts to increase demand by accumulating stocks. This supports market prices. Equivalently, stock accumulation reduces supply available to satisfy final demand. Either way, increasing stocks will increase market prices. If market prices rise above a "call price," the CCC may release stocks, which will increase supplies available and lower prices on the market.

Stocking is modeled as a supply shifter in the FPGE model. Domestic supply available for domestic use or export (XS_i) is expressed net of the quantity of production (XD_i) that is forfeited (XF_i):

(8) $XS_i = XD_i - XF_i$

This redefinition of supply from total production (XD_i) to nonstocked production (XS_i) is also carried through the functions describing the transformation of output between domestic and export uses. In the determination of market-clearing prices, this formulation underscores the distinction between normal inventory demand (DST_i) valued at market prices (P_i) and CCC stock accumulations (XF_i) valued at producer prices (PX_i).

It is a challenge modeling the commodity stocking program to interpret and reconcile economywide data with individual crop and program data. The National Income and Product Accounts (NIPA) treat farm program demand as part of overall government demand (GD_i). Thus, a basic economywide CGE model database not focused on agricultural policies confounds stocks forfeited (XF_i) with government final demand (GD_i). Furthermore, government use of CCC commodities for school lunch programs and other programs is defined as exogenous (not loan program) government demand, so the data on net CCC stock changes are not useful because those data confound farm program stock changes with other changes.

To endogenize the farm program stocking portion of government commodity purchases, the forfeits into stocked commodities (XF_i) are first net out of total government demand (GD_i) data. Then, these GD_i are used to calibrate $GLES_i$, the share of government expenditures per sector exclusive of farm program stock accumulation spending. Government demand for agricultural product i is then interpretable as the share ($GLES_i$) of total nonprogram government spending on goods and services.

The stock purchase program is designed to stabilize the market price near the loan rate. The equation in the model expresses the amount of crop collateral forfeited (XF_i) as an exponential function ($\varphi_i > 1$) of the ratio of the parametric loan rate (PL_i) and the endogenous producer market price (PX_i):

(9) $XF_i = XF^{oo}_i + XF^{o}_i \cdot (PL_i/PX_i)^{\varphi i}$

Note how this equation works. If the endogenous ratio PL/PX does not change from the base year, the equation replicates the data on stocking that year (XF^o).[4] If the ratio is higher (the loan rate is relatively more attractive), more commodities are forfeited ($XF\uparrow$) and accumulated by the CCC. Marketable supplies decrease, so producer market prices (PX) in each sector rise toward the loan rate (PL).

The total cost to the CCC of accumulating crops at producer market prices (CCCE) is:

$$(10)\quad CCCE = \Sigma_i\, XF_i \cdot PX_i$$

This is a government expenditure that must be met by government revenue or borrowing.

Although the FPGE model is a contemporaneous flow model, it can simulate the drawing down of start-of-period inventory when market prices rise above the call rates. This potentiality is handled by setting the lower bound on XF_i below zero by the (negative) level of start-of-period inventories. In effect, as market prices rise above loan rates, this simulates marketable supplies exceeding current production by the amount of destocking simulated according to equation 9.

The basic loan rate is not always the price around which market prices are stabilized. If the basic loan rate is higher than prevailing world prices, to stabilize domestic prices near the basic loan rate would imply that farmers would rather forfeit their crops than export. Export markets may be lost, as indeed it was feared that they were in the early 1980's. There are two provisions in the 1985 farm act (as amended) to deal with this problem. First, the Secretary of Agriculture has the authority to announce a lower loan rate (Findley) around which market prices will be supported, and pay loan deficiency payments to make up the income difference. In that case, the Findley loan rate is the loan repayment rate and the reference price for deficiency payments; but, there is no change to the model. Second, the Secretary has the authority to employ the "marketing loan" program if the loan rate exceeds world market prices. The modeling of that program, since it has important trade implications, is discussed in the section on trade policies.

Loan Forfeit Benefits

As suggested above, the nonrecourse loan program enables participating farmers to hold crops at storage cost for later sale at a better price. The loan rate (PL_i) is the policy instrument. The farmer forfeiting the pledged crop receives the loan rate price per unit forfeited rather than just the market price per unit. This is the loan forfeit benefit (LFB_i). The model determines the loan forfeit benefit as the difference between the loan rate, PL_i, and the variable producer market price, PX_i, times the quantity forfeited, XF_i:

$$(11)\quad \begin{array}{ll} LFB_i = XF_i \cdot (PL_i - PX_i) & \text{if } PL_i > PX_i \\ LFB_i = 0 & \text{if } PL_i \leq PX_i \end{array}$$

The CCC gains title to commodities put up as collateral, then returns only the title to quantities not forfeited. The cost to the CCC of accumulating commodities through forfeits is the loan rate times the amount forfeited, while the value of the commodities is the producer market price times the amount forfeited. This valuation difference is borne by the CCC as part of operating expenses as an

---

[4]The data on XF_i are obtained directly from the Bureau of Economic Analysis section responsible for table 3.19 in the *Survey of Current Business* (U.S. Dept. of Commerce, July issue, any year). The data are aggregated and normalized using the program FARMDATA GAMS shown in Appendix II.

inventory valuation adjustment. The CCC pays $\Sigma_i XF_i \bullet PL_i$ for commodities worth only $\Sigma_i XF_i \bullet PX_i$ at producer market prices. In other words, this inventory value difference is the loan forfeit benefit.

The CCC inventory valuation adjustment is recorded in National Income and Product Account data as part of current surplus (U.S. Dept. of Commerce, 1982). These data are used to calibrate PL_i^o, given the data on XF_i^o and PX_i^o:

(11') $PL_i^o = LFB_i^o/XF_i^o + PX_i^o$

Producer Incentive Equivalent

The deficiency payments and loan forfeit benefits provide the bulk of the additional incentives to employ land, labor, and capital in agriculture. Any assessments that farmers must pay directly offset those incentives. These three elements are summed into the producer incentive equivalent (PIE_i):

(12) $PIE_i = (DEFPAY_i + LFB_i - ASSMNT_i)/XD_i$

How does a change in a policy affect markets? Consider the following example of changing the target price. If a higher target price is announced, this increases DEFPAY and thus the specific subsidy PIE. This raises value-added in the sector. Primary factor employment in the sector rises and increases (shifts out) supply. An increase in output, *ceteris paribus*, lowers the market-clearing price. This further increases the deficiency payment rate and program expenditures.

Without supply controls, payment limitations, or stock accumulation, the deficiency payment program is infeasible. This is particularly apparent in a CGE model. High deficiency payments can attract so much labor and capital into the supported sectors that excessive supplies drive market prices down. In the real world, a policy of unconstrained guaranteed prices could break the public bank. In a model, such a policy would lead to violation of the nonzero price condition, so there would be no feasible solution. This is in fact what happened during the early stages of model development when we added explicitly fixed target prices but had no loan/stocking program or acreage controls.

The FPGE model's set of target prices, loan rates, stocking, acreage reduction, and PIE equations provide a feasible set of equations and conditions for domestic farm policy. Given participation and set-aside rates, any increases in target prices or loan rates shift supply out and so lower the market-clearing price. Farm income rises, however, because it is supported by the deficiency payments and forfeit benefits. If deficiency payments are decoupled from current output, then program output (XP_i) should be left exogenous, and increases in deficiency payments accrue to the owners of the relatively fixed factor of production, land. In either case, as long as market prices are below loan rates, deficiency payments will also be invariant to changes in market prices. The loan forfeit benefits (and thus PIE and CCCE), however, will remain endogenous and rise with increases in stocking and the excesses of loan rates above market prices.

Loan Subsidy Benefits

Under the loan program, the value of a farmer's crop collateral is calculated at the loan rate price. During the period of the loan, farmers may redeem their crop collateral by repaying the loan principal plus interest at a special interest rate. Since the interest rate charged by the CCC is usually lower than the market rate, the nonrecourse loan program provides what is called the loan subsidy benefit (LSB_i).

Producers receive the LSB_i at the loan subsidy benefit rate ($LSBR_i$) per unit of collateral pledged (XL_i):

(13) $LSB_i = LSBR_i \cdot XL_i$

The quantity of commodities put under loan (XL_i) equals the pledge rate (XLR_i) times output (XD_i):

(14) $XL_i = XLR_i \cdot XD_i$

Because the decision to put up collateral is based on expectations of variables exogenous to the CGE model, the crop collateral pledge rates (XLR_i) are exogenous and set at $XLR_i = XL^o_i/XD^o_i$ where the XL^o_i are normalized versions of the data on the quantity of each crop pledged in the benchmark year under the loan program.[5]

The loan subsidy benefit rates ($LSBR_i$) rates are not simple interest rate subsidies. CCC loans are taken out for different amounts of time by various borrowers, and the interest rate differential varies inversely to the underlying market interest rate. The $LSBR_i$ are calibrated to reconcile both with total net interest paid and the face value of loans to each sector. The face value of loans made ($LMFA_i$) is the quantity of crop collateral (XL_i) times the loan rate (PL_i):

(15) $LMFA_i = XL_i \cdot PL_i$

Total net interest paid (NIP) by the CCC is the interest paid by the government on the funds lent less the interest received on all forms of commodity loans (U.S. Dept. of Commerce, 1982).[6] Net interest paid by the government is assumed to be equal to what would otherwise have been paid by farmers, and so it is used to calibrate the loan subsidy benefits ($NIP = \sum_i LSB_i$) . It is assumed that each sector receives a share of loan subsidy benefits that equals the sector's share in total loans made at face value, per unit of collateral:

(16) $$LSBR_i \cdot XL_i = \frac{LMFA_i}{\Sigma_i LMFA_i} \cdot NIP$$

where the observed data on the value of loans made ($LMFA_i$) are used.[7] The loan subsidy benefit reduces the costs of borrowing for participating producers. Interest payments that would have been made by farmers into the consolidated capital account are instead allocated directly to farm households. To reflect this, the LSB_i are modeled as income transfers from the CCC to the agricultural capital institution, which ultimately distributes market and program income to farm households. They are not included in the producer incentive equivalents (PIE_i).

---

[5]The data on XL_i used in this model were obtained directly from the Bureau of Economic Analysis section responsible for table 3.19 in the *Survey of Current Business* (U.S. Dept. of Commerce, July issue, any year). The BEA obtains monthly data from the Commodity Credit Corporation and prepares annual calendar year summaries by crop. An alternative source of data is *Agricultural Statistics* (USDA, any year) in the tables titled "Price-support operations" by crop and crop marketing year. As with alternative data on target prices and deficiency payments, alternative data must be adjusted to the calendar year basis of the rest of the model.

[6]Data on net interest paid can be obtained directly from the Agricultural Stabilization and Conservation Service Budgetary Office reports such as the Mid-Session Reviews or the "History of Budgetary Expenditures" (USDA, any year)

[7]The data on the face value of loans made by crop per fiscal year are taken from "History of Budgetary Expenditures" prepared by the Agricultural Stabilization and Conservation Service (USDA, any year). These data are used to determine the shares to each sector of total loans made, so the fiscal year frequency is not a problem. Aggregation and normalization are done in the FARMDATA GAMS program in Appendix II.

Trade Policies

The United States has developed agricultural trade policies primarily to facilitate the operation of its domestic farm income and price support programs. In the past, import controls were imposed to stop foreign supplies from flooding markets in which government stocking activities supported domestic prices. Export promotion has been authorized since 1935, but only recently has the United States used countervailing subsidies on exports of traditional U.S. agricultural exports that have faced increasing competition from other subsidized producers.

Export Programs

The 1985 farm act authorized export subsidy, promotion, and export credit guarantee programs (Ackerman and Smith, 1990). These export provisions were in addition to ongoing concessionary sales under "Food for Progress" and Public Law 480. None of these sales are allowed to displace commercial sales or affect world market prices.

The export promotion programs that may, however, affect trade and world prices are the Targeted Assistance and the Market Development and Expansion Programs, collectively called Export Enhancement Programs. Under the version called "Export PIK" (payment in kind) programs, the government compensates exporters in kind or otherwise for the difference between the reference world price and the contracted sale price to a specific country. This program is designed to increase the volume of U.S. exports. Given that the United States is large in the world markets for some food and feed grains, changes in the volume of U.S. exports may affect world prices for them.

The extent to which the concessional exports augment rather than simply displace regular commercial sales is called additionality. Additionality is an increasing function of the importer's elasticity of demand (Houck, 1986a). In this model, we use high elasticities of foreign demand for our exports (ϵ_i). This implies that we assume high additionality. The effect of the Export Enhancement Program is to lower "world" prices for U.S. exports (PWE_i) relative to other country export prices ($PWSE_i$), which are assumed exogenous. On net, the price of U.S. exports to world customers is lower under the program. There is only a small effect on the U.S. domestic price of exportables (PE_i).

The export enhancement subsidy is expressed in the FPGE model as an *ad valorem* markup (TEE) over the U.S. export price (PWE) to be received by exporters. TEE makes up the difference between the low prices paid for U.S. exports (PWE•EXR) and the prices domestic suppliers receive for exportables (PE):

$$(17) \qquad PE_i = EXR \cdot PWE_i \cdot (1+TEE_i)$$

where EXR is the (direct quote) exchange rate of dollars to foreign currency. An increase in the average rates of targeted export assistance or export PIK payments lowers the customers' cost for U.S. exported products (PWE_i) relative to any other export supply price ($PWSE_i$).

Export volume in markets where the United States is "large" is inversely related to the U.S. export price (PWE_i). An increase in the export subsidy rate decreases PWE_i relative to $PWSE_i$. Total export volume rises:

$$(18) \qquad E_i = EBAR_i \cdot (PWSE_i/PWE_i)^{\epsilon i}$$

Do not overlook the expenditure side. The Export Enhancement Program provides export subsidies disbursed as in-kind payments to U.S. exporters. The titles to stocks used to implement the scheme simply redefine part of the cost of CCC stocks carried over from previous periods as export bonus

expenditures. This transfer between accounts results in no net effect on retail prices (P_i and PE_i). It is assumed that the bonuses will be made only out of stocks, not out of current CCC accumulations.

The export subsidies (EEP_i) are a cost item on the government budget and are credited to the owners of the claims on export income through the domestic value of exports:

(19) $EEP_i = TEE_i \cdot PWE_i \cdot E_i \cdot EXR$

Marketing Loans

If the world market price is above the loan rate, the operation of the domestic loan programs poses little threat to U.S. export competitiveness. Since 1982, however, world prices have fallen below U.S. loan rates. Without amendments to the farm act, U.S. export prices would have been supported near the basic or the Findley loan rates, which were both above competitor's prices. This would dampen U.S. trade (Hanthorn and Glauber, 1987).

The marketing loan program is designed to make U.S. exports available at world prices. Participants are allowed to repay their commodity loans at the prevailing world market prices rather than at the loan rate. Having cleared their loan and redeemed their crops, producers can sell the crops at the world market price, and pick up increased loan forfeit benefits to makeup for the shortfall in price. This benefit is called the marketing loan gain.

When marketing loan programs are in effect, the U.S. market price is stabilized near the world price. The 1985 farm act stipulated that the marketing loan repayment rate should be the higher of the world market price or a given percentage of the current loan rate. The formulas and regulations are described in detail in Hanthorn and Glauber (1987). The argument that the marketing loan repayment rate serves as a price floor can also be found in Glauber (1986). This is modeled by using the marketing loan repayment rate ($MLPL_i$) in the equation for price support via government stocking (equation 9) rather than the loan rate:

(9') $XF_i = XF^{oo}{}_i + XF^{o}{}_i \cdot (PX_i/MLPL_i)^{\varphi i}$

While this feature of the program stabilizes market prices toward the stipulated MLPL, the program does not reduce returns to producers due to the provision of marketing loan gains. The marketing loan gain (MLG_i) is the difference between the loan rate and the marketing loan program repayment rate times the quantity of the crop redeemed from under loan (XL_i-XF_i). We assume that all pledged commodities not forfeited are redeemed at the marketing loan repayment rate when such a program is in effect:

(20) $MLG_i = (XL_i - XF_i) \bullet (PL_i - MLPL_i)$

The marketing loan gain would be added into PIE for each sector in which it is available. These gains to farmers are also a cost to the government. The sum cost over all crops for which marketing loans are offered is included explicitly in the government budget. The great costs of the marketing loan program have been weighed against the benefits of maintaining U.S. exports, and thus marketing loans have been made available only to cotton rice producers in the past, and are not likely to be much used in the future.

Import Programs

The President has the authority under Section 22 of the Agricultural Adjustment Act of 1933 to impose import restrictions to protect domestic support programs. The Foreign Agricultural Service monitors and administers the Section 22 import restrictions. This act was not invoked until 1953 to apply quotas against manufactured dairy product imports. It has been invoked for a variety of agricultural products since then (USDA, 1988). This section considers both import quotas and tariffs. First, we review the modeling of import demand.

As in the basic model, this model invokes an Armington assumption to distinguish domestic from foreign goods in demand.[8] Imports are assumed to be imperfect substitutes for the domestic versions of the goods. Consumers purchase a mix of the two types of commodities. This mix is a constant elasticity of substitution [CES] aggregation of the imported and domestically produced versions of the good:

(21) $X = A \cdot (\delta \cdot M^{-\rho} + (1-\delta) \cdot XXD^{-\rho})^{-1/\rho}$

(sector subscripts are dropped for simplicity) where A is a demand shift term, the δ are shares, and the elasticity of substitution (σ) is expressed as $1/(1+\rho)$. This implies that the domestic sales price (P) is a CES aggregation of the imported version price (PM) and the domestic version price (PD):

(22) $P = 1/c \cdot [\delta^{\sigma} \cdot PM^{1-\sigma} + (1-\delta)^{\sigma} \cdot PD^{1-\sigma}]^{1/(1-\sigma)}$

Consumer demand is the outcome of utility maximization, given prices and budget constraints. The dual to this is expenditure minimization. The mix or ratio of imports to domestic goods in total demand (M/XXD) is accordingly determined to minimize the cost of the composite good (X). The optimal ratio is given by the first-order condition as a function of relative prices as:

(23) $M/XXD = [(PD/PM) \cdot \delta/(1-\delta)]^{\sigma}$

Tariffs

The average tariff rate on all imports to the United States is about 4 percent. The United States collects above-average tariffs on imports of nuts, tobacco and products, vegetables, peanuts, processed dairy products, canned and frozen foods, and textiles.

A tariff is a tax on imports, ultimately paid by the consumer to the government. In the CGE model, all tariffs are expressed as a proportional markup over the world import price. Any specific tariffs are converted to their *ad valorem* equivalents by dividing tariff revenues by the value of imports at world prices. An increase in the tariff rate (TM_i) over a given world price of imports (PWM_i) increases the domestic dollar import price PM_i:

(24) $PM_i = PWM_i \cdot (1+TM_i) \cdot EXR$

Since import demand is inversely related to price (first-order condition, equation 23), the addition of tariffs reduces import demand. The tariff revenues received (TARIFF) go to the government:

(25) $TARIFF = \Sigma_i \, TM_i \cdot M_i \cdot PWM_i \cdot EXR$

---

[8]The original Armington framework is by Armington (1969). For discussion of its appropriateness in CGE models, see Whalley and Yeung (1984) and the critique by Alston and others (1990).

Quotas

In 1986, the United States continued the historic pattern of global quotas (limits on the quantity or value of specified imports from all countries) on cotton, dairy products, peanuts, sugar, and certain sugar products (IMF, 1987).

By creating an artificial scarcity, quotas raise the price of the import so that the prices of domestically produced import-competing goods can also rise. This is how quotas support domestic market prices above world prices. The protected domestic producer receives the high price per unit of domestic product either directly from the consumer or indirectly from a processor. The high domestic price of the imported product also provides scarcity rent income to entrepreneurs. The difference between the high domestic price and the low world price per unit imported is captured as premia by those with the license to trade the restricted commodities.

The parameters of the unconstrained demand function equation 21 must be calibrated from the observed, constrained demand behavior. The first question to ask in modeling quotas is whether or not consumers are also rationed at the premia-ridden prices (Dervis and others, 1982). If they are rationed, the observed mix in demand is not the mix that would be chosen at the observed relative prices. For this model of the United States, it is assumed that the observed levels of imports and domestic good consumption reflect optimal demand behavior at the prevailing (distorted) relative prices. The problem then reduces to determining what domestic import prices would be if there were no quota (Neary and Roberts, 1980).

The United States is small in international markets for the quota commodities of sugar and dairy products (Anderson, 1988). Thus, the world price (times the exchange rate plus any tariffs) gives the domestic price of imports without quotas. This is PM_i in the model. The observed PM_i and PD_i are used to calibrate the demand functions for the mix of imports and domestic versions in the benchmark year.

The second challenge is to trace the quota premia to the recipients. The domestic producers of the import-competing versions do not necessarily capture the quota premia. Quota premia go to the licensed traders, who may even be foreign suppliers. For example, the U.S. trade policy for sugar is a quota-cum-tariff (Lord and Barry, 1990).[9] The licenses to export sugar to the United States are assigned country by country. The sugar exporters pick up the difference between the world price and the U.S. price plus the tariff. U.S. sugar importers pay the tariff duty to the U.S. Government and most of the premia accrue to the foreign exporters. Under the sugar policy, the foreigners share the premia with the U.S. Government. In the dairy sector, about 90 percent of the licenses to import are distributed to cheese-importing firms, the rest to U.S. dairy processors according to their share in domestic production. Under the dairy policy, private domestic groups get the premia.

With quotas, any difference between the domestic price of imports (PM_i) and what foreign suppliers charge (PWM_i) (plus tariffs) is the premium ($PREMIUM_i$) received by licensed traders for each unit imported:

$$(26) \qquad PREMIUM_i = \{PM_i - [PWM_i \cdot (1+TM_i) \cdot EXR]\} \cdot M_i$$

[9]For sectors such as sugar where the government both collects duties and imposes quotas, the model determines the tariff revenues according to the equations (24') and (25), and determines the premia according to (26). That is, the premium does not double-count the tariffs collected by the government.

These premia are distributed to the owners of nonfarm capital because they are picked up only by licensed traders (not milk, sugarcane, or sugarbeet producers).[10]

The quota policy instrument is the level of allowed imports. It is explicitly modeled as a constraint (upper bound) on imports of quota sectors (M_{iq}):

$$(27) \quad M_{iq} = \overline{M}_{iq}$$

The addition of this constraint will interfere with the determination of the optimal mix of imports in the consumption bundle (equation 23) unless something else can vary. The additional variable is TMQ_{iq}, the flexibility in the domestic price of imported versions of quota goods that reflects the premium induced by the scarcity of imports:

$$(24') \quad PM_{iq} = PWM_{iq} \cdot (1 + TM_{iq} + TMQ_{iq}) \cdot EXR$$

The TMQ_{iq} are endogenous tariff equivalents of the quota premia per unit imported:

$$(28) \quad TMQ_{iq} = PREMIUM_{iq}/(EXR \cdot M_{iq} \cdot PWM_{iq})$$

TMQ_{iq} does not function as a fixed *ad valorem* equivalent of the quota. TMQ_{iq} is endogenous because the premium is endogenous. The price domestic consumers are willing to pay (PM_{iq}) for the fixed level of imports under the quota does not change even if world prices change. For example, a decrease in the world price of dairy products at the U.S. border (PWM_{dairy}) relative to the domestic price raises the premium to U.S. licensed importers. There is no change in domestic prices, imports, or domestic supply.

The U.S. sugar policy is such that the administration can use the quota to maintain domestic prices at the desired support level regardless of fluctuations in domestic demand or domestic supply. Because changes in domestic demand or supply shift the import demand schedule, domestic price stability is achieved by shifting the quota constraint. This is accomplished by lengthening or shortening the period of time during which the quota can be filled. In effect, this relaxes or tightens the restriction for a given period. It is modeled by using equation 27 to fix the domestic price (P_{sugar}), and allowing the quota level of imports (M_{sugar}) to be determined endogenously to maintain that price.

Dairy Policies

The price of milk is determined by the derived demand for milk as an intermediate good in dairy product manufacturing relative to market supply. The dairy policy relies on supporting that price through a two-tier grading and milk-pricing system, direct dairy product purchases, and import quotas that shift domestic demand.

The artificially high demand for domestically produced milk is induced by the artificial scarcity of imported milk products due to the quotas. The quotas are modeled as explained above. Unlike sugar, the dairy quota period is not fungible. To maintain domestic prices at the desired support level, the government may directly purchase butter, cheese, nonfat dry milk, and other dairy products. This reduces marketable supplies as in stocked program crops.

---

[10]The data on world prices for sugar are taken from Barry and Angelo (1988) and Morkre (1990). Data for the dairy processing sector are secondary estimates from Anderson (1990). Information about "who gets the premia" in the dairy industry is interpreted from USDA (1988) and from Anderson (1988).

Price Support

The direct purchase program in the dairy processing sector is modeled by the same equation that determines government stocking of food grains and feed crops under the nonrecourse loan program. The difference between stocks accumulated as direct purchases or as loan collateral is largely semantic from the point of view of the producer. The difference is that price support afforded by direct purchases must be absolute, while the loan program allows for slack between market and loan prices. This difference is reflected in the model by specifying the stocking function as highly elastic in the direct purchase sectors. This results in a direct purchase behavior that maintains producer prices at the support level.

Dairy Assessments

As with the grain programs, dairy production must be constrained to avoid breaking the public bank. Two programs were legislated in the 1985 farm act. One was the whole herd buyout program; the other was the milk diversion program. Both programs compensate participants for reducing production, in cash. This cash is provided by lowering the milk support price received by producers. The handlers continue to pay the support price by law, but the difference is returned to the government to be distributed only to participating producers.

These programs are modeled by adding a tax on dairy products equal to the sum of the assessments per unit sold. This specific tax ($ASSMNT_{dairy}$) enters the model through the equation for PIE:

$$(12) \quad PIE_{dairy} = (LFB_{dairy} - ASSMNT_{dairy})/XD_{dairy}$$

where the effect of the direct purchase program on producer returns is reflected by LFB_{dairy} (direct purchase accumulations have the same effect on prices as forfeits at the support price); but some of those benefits are returned to the CCC via assessments, to be distributed only to participants. The compensation to participants is distributed as a direct transfer and grossed into the direct transfer variable (DIRPAY).

Tax Policies

CGE analyses of tax policies have previously been published by Ballard and others (1985) and, focusing on the farm sector, Hertel and Tsigas (1988). Both studies find that agricultural households pay taxes at lower rates than households claiming mostly nonfarm income in the United States.

Hertel and Tsigas calibrate these preferential tax rates entirely at the farm household level. They found that effective tax rates on capital and labor income were lower for agricultural than non-agricultural sectors. In contrast to the approach taken by Hertel and Tsigas, taxes in this model are calibrated separately at the factor, institution, and household levels. Factor taxes, such as social security, are paid on value-added to primary factors and are, in principle, the same across sectors.

Enterprise tax rates are calibrated at the institutional level because there are three main differences between farm and nonfarm tax liability determination. First, farm businesses are allowed to use the cash method of accounting. Second, depreciation allowances are different between farm and nonfarm capital. Third, farmers can take advantage of special provisions for fertilizer and soil conditioning expenditures (although this is best modeled explicitly, as shown below).

Farm Income Taxes

Income taxes are paid on gross household income, with the rates differing across income classes and between farm and nonfarm households. The household income tax rates used in the model are calculated from the actual data on income taxes paid over gross income by group. It is assumed that the taxable portion of income is invariant to changes in the rate of taxation.

Input Tax Credits

Previous farm acts included tax credits on fuels used on the farm. The 1985 act provided for some tax credits for land improvements. These can both be modeled as subsidies on intermediate goods used in production received per unit of the input used (SUBR) from the government. To take input subsidies into account, the PVA is adjusted as follows:

$$(3') \qquad PVA_i = [(1\text{-}ITAX_i) \cdot PX_i] - \Sigma_j IO_{j,i} \cdot (P_j\text{-}SUBR_{j,i}) + PIE_i$$

To model the input subsidy as a tax credit, the indirect taxes received by the government are reduced by the amount of the subsidy to each sector, $\Sigma_j IO_{j,i} \cdot SUBR_{j,i}$.

Farm Program Expenditures

The fundamental discipline of Walrasian CGE modeling is to maintain receipt/expenditure balance and market clearing. Furthermore, all policy instruments and parameters of program behavioral equations must be calibrated so that benchmark simulation results replicate the observed levels of production, stocks, prices, program expenditures, and other results. To guarantee Walras' Law across experiments, functional forms for behavioral relationships must have the appropriate homogeneity properties. Finally, only when expenditures balance receipts (even in the *n*th market for which the market-clearing equation is dropped) is the modeler assured that Walras' Law is satisfied.

The preceding sections dealt with how the farm program subsidies are determined, how the behavioral equations are specified, and how the taxes and assessments are paid. This section presents the government expenditure side.

Government expenditure to support farmers consists of some sunk or nonrecoverable costs and some recoverable costs. The components of these two types of spending are listed in table 5 for the benchmark year. All direct payments in cash or in kind (deficiency, EEP, conservation reserve, and other payments) are nonrecoverable costs. Stock accumulation expenditures are recoverable, net of the inventory valuation adjustments (loan forfeit benefits) because the stocks can in principle be sold someday. The FPGE model determines 100 percent of the recoverable and 91 percent of the non-recoverable spending explicitly. The remaining 9 percent of nonrecoverable spending is modeled as lump-sum transfers or current operating expenses by the government through the government's purchases of services.

Both the explicitly modeled portions and the lump-sum transfers (and receipts) are summarized in the model into the measure FPE:

$$(28) \qquad FPE = (\Sigma_i\, DEFPAY_i + LFB_i + LSB_i + MLG_i + EEP_i - ASSMNT_i) + CCCE + DIRPAY + FORTOT$$

where: FPE is Farm Program (net) Expenditure

$DEFPAY_i$	DEFiciency PAYments to the ith sector
LFB_i	Loan Forfeit Benefits "
LSB_i	Loan Subsidy Benefits "
MLG_i	Marketing Loan Gains "
EEP_i	Export Enhancement Program expenditures to ith sector
$ASSMNT_i$	ASSMeNTs received from the ith sector
CCCE	Commodity Credit Corporation Expenditure on forfeits
DIRPAY	all other DIRect PAYments
FORTOT	payments under the Farmer-Owned Reserve program, TOTal

Expenditures are counted against revenues in the government budget equation:

(29) $$GOVSAV = GR - GDTOTN - GENT - HHT - FBOR \cdot EXR - FPE$$

Table 5--Selected nonrecoverable and recoverable outlays to farmers, 1986

Nonrecoverable Item		Outlays	Recoverable Item		Outlays
		Million dollars			*Million dollars*
Direct payments			Net loans by CCC		8,310
Deficiency payments(cash)		6,473	Food grains	924	
Food grains	1,997		Feed grains	6,686	
Feed grains	3,593		Oil crops	617	
Cotton	883		Cotton	83	
Payments in kind		3,631	Direct dairy purchases		1,812
Diversion payments(cash)		23	Total recoverable		10,122
Dairy	1				
Food grains	0		Nonrecoverable plus recoverable		
Feed grains	19		GRAND TOTAL		21,939
Cotton	3				
Dairy herd buyout		621			
Conservation reserve program		83			
Reserve storage payments		633			
Food grains	175				
Feed grains	458				
Other programs		353			
Total nonrecoverable		11,817			

Note: These are not official CCC numbers.
Source: *Food and Agriculture Situation and Outlook*, 1989.

where GOVSAV is the government deficit (if negative), GR is government revenue (net of input subsidy tax credits), GDTOTN is government final demand, GENT are nondistorting transfers to nonagricultural enterprises, HHT are transfers to households, and FBOR is net official foreign borrowing. Increased farm program spending (FPE) *ceteris paribus* increases the deficit.

This deficit is financed out of loanable funds (gross savings from domestic and foreign private and official sources). If a savings equals investment macro closure is used, increases in farm program expenditures crowd out domestic investment. As noted in the introduction, the effect of changes in farm program expenditures on the government deficit, and thus the level of investment, is an important indirect farm/nonfarm linkage.

The 1986 Farm Programs SAM

The data used to calibrate and initialize all Walrasian CGE models must come explicitly or implicitly from a balanced social accounting matrix (SAM). A balanced SAM is an accounting framework that satisfies the fundamental Walrasian properties that each economic agent's expenditure equals income and that all markets clear. To calibrate the farm programs model so that Walras' Law is assured, detail is needed on government expenditures and farmer receipts for each type of farm program in every farm sector, and for each farm income-receiving household. All the data must reconcile with the National Income and Product Accounts data. Two articles from the *Survey of Current Business* are most useful in this regard: U.S. Dept. of Commerce (1982) and Wakefield, 1986.

A schematic SAM for the farm programs model is presented in table 6. An account for the CCC is explicitly included. The GAMS code for setting up this SAM is included in the FPGE model code in Appendix I.

As in all SAMs, column entries represent expenditures by an account. For example, the activities (A) must pay for intermediate goods, primary factors, and indirect taxes. The dairy sector must also pay assessments. The government (G) spends its revenues on nonfarm program final demand, provides enterprise and household transfers, finances the net farm program expenditures (FPE), reconciles its budget by borrowing from the capital account, and makes official loans and interest payments to foreigners.

The row entries are the receipts to an account. For example, the commodities account (C) row entries represent the value of commodities sold at the final market prices (P_i) as intermediate goods to consumers, to the government, for stocks, and for capital investments. The CCC acquires commodities directly from the producer rather than the market, so the nominal flow of CCC forfeits at producer prices (PX) should be an entry in the activities row and the CCC column. The (A,CCC) cell already includes the distorting nominal flows from the CCC to farmers, DEFPAY + LFB + EEP. Instead, the value of forfeited commodities at producer market prices is shown in the commodities row to distinguish the recoverable from the nonrecoverable expenditures.

Table 7 presents the aggregated, balanced nominal SAM data for 1986. Note the accuracy with which the model replicates the data on farm program spending. The CCC row (or column) sum represents gross spending to support agriculture in 1986. The assessments collected by the CCC (CCC,A) plus the government net financing of the CCC (CCC,G) equals the gross CCC budget for farm and export program spending during 1986. This is the sum of $27.2 billion.

Of that total, the model reports that $9.5 billion is recoverable spending on stock accumulation (C,CCC). This exactly matches the calendar year data obtained from the Bureau of Economic Analysis, and approximates the $10.1 billion on "recoverable spending" in the data shown in the

Table 6 -- Schematic SAM

	C	A	F	I	HH	G	CCC	K	W
Commodities		Intermediate input use			Consumer demand	Gov't demand	FORFEITED COMMODITY	DST & ID	
Activities	Domestic production						DEFPAY, LFB EEP & MLG		Exports
Factors		Gross factor income							
Institution	Premia		Factor income			Transfers	DIRPAY, LSB & FORTOT		Remits
Households				Household income					
Government	Tariffs	Indirect taxes		Land, labor, & capital tax	Household taxes				
CCC		Assessments				FPE ex.ASSMNTS			
Kapital				Depreciation and saving	Household saving	Gov't budget surplus			Foreign saving
World	Imports					Official lending			

Note: SAM entries in capital letters are FPGE model variable names

Table 7 -- Nominal SAM for United States, 1986; model solution

	COMMDTY	ACTIVITY	FACTORS	INST	HHOLDS	GOVT	CCC	KACCT	WORLD	TOTALS
					Billion dollars					
COMMDTY		3267.305464			2798.207934	862.910988	9.526647	657.920321		7595.871354
ACTIVITY	7138.766155						15.929000		311.470380	7466.165535
FACTORS		3862.229128								3862.229128
INST	0.353140		3862.229128			565.334192	1.758420		32.479535	4462.154414
HHOLDS				3435.217108						3435.217108
GOVT	13.747445	336.343523		484.876442	512.244987					1347.212397
CCC		0.287420				26.926647				27.214067
KACCT				542.060865	124.764187	-144.436446			135.531716	657.920321
WORLD	443.004614					36.477016				479.481631
TOTALS	7595.871354	7466.165535	3862.229128	4462.154414	3435.217108	1347.212397	27.214067	657.920321	479.481631	

Note: This is the SAM as generated and displayed by the FPGE GAMS model.

fiscal year numbers (table 5). The differences between the BEA's data and ERS numbers may also arise from alternative estimates of the market value of CCC inventory.

The SCB reports net stocking of $6.8 billion (line 7, table 3.19, *Survey of Current Business* (U.S. Dept. of Commerce, July issue; any year). This is the $9.5 billion worth of commodities accumulated, net of the nonfarm program government uses or sales of stocks. The value of government purchases out of stocks is the difference between $9.5 billion and $6.8 billion This implies that the government has used or sold $2.7 billion worth of stocked commodities for nonprogram reasons.

The total nonrecoverable spending is reported as $17.4 billion by the CCC to the Bureau of Economic Analysis (line 13, table 3.19, *Survey of Current Business* (U.S. Dept. of Commerce, July issue; any year)). The model estimates that figure exactly, as shown by the sum of the (A,CCC) and (INST,CCC) cell entries, minus assessments in (A,CCC). Assessments are $0.28742 billion. That $17.4 billion figure includes the $11.8 billion of nonrecoverable payments (table 5). The $17.4 billion also includes all the other subsidies, including the loan forfeit benefits ($\Sigma_i LFB_i$) of approximately $4 billion and the commodity costs of the various export programs.

The sum of net commodity purchases and subsidies less current surplus is $24.2 billion. The difference of $0.2 billion between the model and the SCB estimate of expenditures is due to the items on lines 10-11-12 of table 3.19, not considered to be farm program expenditures. The interest paid data are already accounted for from loan records, so the total of -$0.2 billion is also net out, to total $24 billion net farm program expenditures in 1986.

The FPGE model thus replicates the $24.0 billion reported as "Commodity Credit Corporation expenditures, National Income and Product Accounts," line 6 in table 3.19 of the *Survey of Current Business* (U.S. Dept. of Commerce, July issue; any year). This feature is crucial for achieving Walras' Law. Given Walras' Law, we can rest assured that no change in farm programs or farm spending will be overlooked or underdetermined. There are no leakages in the system of equations called the FPGE-CGE model.

References

Ackerman, Karen Z., and Mark E. Smith (1990). *Agricultural Export Programs: Background for 1990 Farm Legislation*. Staff Report No. AGES 9033. Economic Research Service, U.S. Dept. of Agriculture, May.

Ahearn, Mary (1986). *Financial Well-Being of Farm Operators and Their Households*. AER-563. Economic Research Service, U.S. Dept. of Agriculture, September.

Alston, Julian, Colin Carter, Richard Green, and Daniel Pick (1990). "Whither Armington Trade Models," *American Journal of Agricultural Economics*, Vol. 72, No. 2, pp. 455-468, May.

Anderson, James E. (1988). *The Relative Inefficiency of Quotas*. MIT Press, Cambridge, MA.

Anderson, James E. (1990). "The Coefficient of Trade Utilization," paper presented at the NBER Conference on Empirical Trade Issues, March, citing E. Hornig, R.N. Boisvert, and D. Blandford (1988) "Quota Rents and Subsidies: The Case of U.S. Cheese Import Quotas," Cornell Univ.

Armington, Paul S. (1969). "A Theory of Demand for Products Distinguished by Place of Production," *International Monetary Fund Staff Papers*, Vol. 16, pp. 159-176, March.

Ballard, Charles, Don Fullerton, John Shoven, and John Whalley (1985). *A General Equilibrium Model for Tax Policy Evaluation*. Univ. of Chicago Press.

Barry, Robert D., and Luigi Angelo (1988). "U.S. Sugar Programs and Program Operations, 1977-87," *Sugar and Sweetener Situation and Outlook*. Economic Research Service, U.S. Dept. of Agriculture, March.

Bentley, Susan E. (1988). *Transfer Payments and Investment Income in the Nonmetro United States*. RDRR-71, Economic Research Service, U.S. Dept. of Agriculture, June.

Bhagwati, Jagdish, and T.N. Srinivasan (1973). "The General Equilibrium Theory of Effective Protection and Resource Allocation," *Journal of International Economics*, Vol. 3, pp. 259-282, August.

Boxley, Robert F. (1985). "Farmland Ownership and the Distribution of Land Earnings," *Agricultural Economics Research*, Vol. 37, No. 4, Fall.

Brooks, Nora L., and Donn A. Reimund (1989). *Where Do Farm Households Earn Their Incomes?* AIB-560. Economic Research Service, U.S. Dept. of Agriculture, February.

Burniaux, Jean-Marc, Francois Delorme, Ian Lienert, John P. Martin, and Peter Hoeller (1988). *Quantifying the Economywide Effects of Agricultural Policies: A General Equilibrium Approach*. Working Paper No. 55, OECD Department of Economics and Statistics, 2 rue Andre Pascal, 75775 Paris, cedex 16, France, July.

Chattin, Barbara, and Fred Nelson (1988). "The United States," *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-86*. Staff Report AGES-880127. Economic Research Service, U.S. Dept. of Agriculture, April.

Dervis, Kemal, Jaime DeMelo, and Sherman Robinson (1982). *General Equilibrium Models for Development Policy*. Cambridge University Press, Cambridge, U.K., and New York.

Evans, Sam, and J. Michael Price (1989). "Income and Price Support Programs," Chapter 7 in *Agricultural-Food Policy Review: U.S. Agricultural Policies in a Changing World*. AER-620. Economic Research Service, U.S. Dept. of Agriculture, November.

Glaser, Lewrene K. (1986). *Provisions of the Food Security Act of 1985*. AIB-498. Economic Research Service, U.S. Dept. of Agriculture, April.

Glauber, Joseph (1986). "How Marketing Loans Would Determine Price Floors for Wheat and Feed Grains," *Feed Situation and Outlook*. Economic Research Service, U.S. Dept. of Agriculture, August.

Green, Robert C. (1990). *Program Provisions for Program Crops: A Database for 1961-90*. Staff Report AGES 9010. Economic Research Service, U.S. Dept. of Agriculture, March.

Hanthorn, Michael, and Joseph Glauber (1987). *An Assessment of Marketing Loan Program Options*. AER-581. Economic Research Service, U.S. Dept. of Agriculture, December.

Harrison, Glenn W., and H.D. Vinod (1990). "The Sensitivity Analysis of Applied General Equilibrium Models: Completely Randomized Factorial Sampling Designs." Photo-reproduction from G.W. Harrison, Dept. of Economics, Univ. of South Carolina, Columbia, April.

Hertel, Thomas, and Marinos Tsigas (1988). "Tax Policy and U.S. Agriculture: A General Equilibrium Analysis," *American Journal of Agricultural Economics*, (70) No. 2, May.

Houck, James, Martin Abel, Mary Ryan, Paul Gallagher, Robert Hoffman, and J.B. Penn (1976). *Analyzing the Effect of Government Programs on Crop Acreage*. TB-1548. Economic Research Service, U.S. Dept. of Agriculture, August.

Houck, James P. (1986a). *The Basic Economics of an Export Bonus Scheme*. IATRC Working Paper #86-1. Dept. of Agricultural and Applied Economics, Univ. of Minnesota, January.

Houck, James P. (1986b). *Elements of Agricultural Trade Policies*. MacMillan Publishing Co., New York.

International Agricultural Trade Research Consortium (IATRC) (1990). *The Potential Use of an Aggregate Measure of Support*. Commissioned Paper No. 5, Univ. of Missouri-Columbia.

International Monetary Fund (IMF) (1987). *Exchange Arrangements and Exchange Restrictions*. Annual report.

Kennedy, Joseph P. (1987). "Generic Commodity Certificates: How They Affect Markets and the Federal Budget," *Choices*, Third Quarter.

Kilkenny, Maureen (1989). "Balanced Matrices in Computable General Equilibrium Modeling" (photocopy), paper presented at the Graduate Operations Research Colloquium, Penn State Univ., October.

----------------- (1991). "The '30-30-30 Proposal' to the GATT Concerning Agriculture: CGE Simulation of Unilateral Compliance by the USA to Partial Liberalization" (photocopy), paper presented at seminar "The Current Proposal to the GATT," Dept. of Agricultural Economics, Michigan State Univ., January.

Kilkenny, Maureen, and Sherman Robinson (1989). "Modeling the Removal of Production Incentive Distortions in the U.S. Agricultural Sector," *Agriculture and Governments in an Interdependent World*. Allen Maunder and Alberto Valdes, editors; Proceedings of the XX ICAE, Dartmouth Publishing Co. Hants, England, pp. 553-564.

------------------ (1990a). *Economywide Implications of Agricultural Liberalization in the United States*. Staff Report No. 9008. Economic Research Service, U.S. Dept. of Agriculture, January.

---------------- (1990b). "Computable General Equilibrium Analysis of Agricultural Liberalization: Factor Mobility and Macro Closure," *Journal of Policy Modeling*, Vol. 12, No. 3, pp. 527-556.

Kramer, Randall, and Rulon D. Pope (1981). "Participation in Farm Commodity Programs: A Stochastic Dominance Analysis," *American Journal of Agricultural Economics*, Vol. 63, No. 1, Feb., pp. 119-128.

Lipton, Kathryn L., and Susan L. Pollack (1989). "Glossary of Food and Agricultural Terms," *Agricultural-Food Policy Review: U.S. Agricultural Policies in a Changing World*. AER-620. Economic Research Service, U.S. Dept. of Agriculture, November.

Lord, Ron, and Robert D. Barry (1990). *The World Sugar Market--Government Intervention and Multilateral Policy Reform*. Staff Report No. AGES 9062, Economic Research Service, U.S. Dept. of Agriculture, September.

Magiera, Stephen L., Maury E. Bredahl, Karl Meilke, T.K. Warley, and Nicole Ballenger (1990). *Reinstrumentation of Agricultural Policies*. Commissioned Paper No. 6. International Agricultural Trade Research Consortium, Univ. of Missouri-Columbia, June.

McDonald, Bradley J. (1990). "Agricultural Negotiations Late in the Uruguay Round: Ten Scenarios for the Eleventh Hour" (photocopy), paper presented at the seminar "Analytical Issues and Developments in the Uruguay Round," Cambridge, MA, August.

Morkre, Morris (1990). "The Economic Effects of Significant U.S. Import Restraints," Investigation No. 332-262. U.S. Federal Trade Commission, February.

Nelson, Frederick, (1988). "United States," *Agriculture in the Uruguay Round: Analyses of Government Support*. Staff Report No. AGES-880802. Economic Research Service, U.S. Dept. of Agriculture, December.

Neary, John P., and K.W.S. Roberts (1980). "The Theory of Household Behavior Under Rationing," *European Economic Review*, No. 13, pp. 25-42.

Office of Management and Budget (OMB) (1990). *The United States Budget in Brief*. Fiscal year 1990.

Perry, Gregory M., Bruce McCarl, M.E. Reister, and James Richardson (1989). "Modeling Government Program Participation Decisions at the Farm Level," *American Journal of Agricultural Economics*, Vol. 71, No. 4, November.

Rausser, Gordon, and Brian Wright (1987). "Alternative Strategies for Trade Policy Reform" (mimeo), paper prepared for the Benjamin E. Lippincott Symposium on Policy Coordination in World Agriculture, Univ. of Minnesota, April. 22-24.

Robinson, Sherman, Maureen Kilkenny, and Irma Adelman (1989). "The Effect of Trade Liberalization in Agriculture on the U.S. Economy: Projections to 1991," in A. Stoeckel, S. Cuthbertson, and D. Vincent (editors); *Macroeconomic Consequences of Farm Support Policies*, Durham, NC: Duke University Press.

Robinson, Sherman, Maureen Kilkenny, and Kenneth Hanson (1990). *The USDA/ERS Computable General Equilibrium (CGE) Model of the United States*. Staff Report No. AGES 9049. Economic Research Service, U.S. Dept. of Agriculture, June.

Salathe, Larry E., J. Michael Price, and Kenneth Gadson (1982). "Food and Agricultural Policy Simulator (FAPSIM)," *Agricultural Economics Research*, Vol. 34, No. 2, April.

U.S. Department of Agriculture (USDA) (1987). "Special Reprint: Generic Certificates," *Agricultural Outlook*. Economic Research Service, April.

U.S. Department of Agriculture (USDA) (1990). *Agricultural Outlook*. p. 61, November.

U.S. Department of Agriculture (USDA) (1988). *Agricultural Statistics*.

U.S. Department of Agriculture (USDA) (1989a). *Economic Indicators of the Farm Sector: National Financial Summary, 1988*. ECIFS 8-1, Economic Research Service, September.

U.S. Department of Agriculture (USDA) (1989b). *GATT and Agriculture: The Concepts of PSE's and CSE's*. MP-1468. Economic Research Service, April.

U.S. Department of Agriculture (USDA) (1990). *History of Budgetary Expenditures of the Commodity Credit Corporation: Fiscal Years 1980-1989*. ASCS/BUD/CPB/1/29/90, Agricultural Stabilization and Conservation Service, January.

U.S. Department of Agriculture (USDA) (1988). "Import Controls under Section 22 of the Agricultural Adjustment Act, as amended," Foreign Agricultural Service, April.

U.S. Department of Commerce (1984). *Money Income of Households, Families, and Persons in the United States: 1982*. Current Population Reports, Series P-60, No. 142. Bureau of the Census, February.

U.S. Department of Commerce (1989). *Rural and Farm Population: 1988*. Current Population Reports, Series P-20, No. 439. Bureau of the Census and USDA, August.

U.S. Department of Commerce (1982). "Special Note.-The Commodity Credit Corporation in the National Income and Product Accounts," *Survey of Current Business*, Vol. 62, No. 1, Bureau of Economic Analysis, January.

U.S. Department of Labor (1986). *Consumer Expenditure Survey: Interview Survey, 1982-83*. Bureau of Labor Statistics Bulletin 2246, February.

Wakefield, Joseph C. (1986). "Federal Farm Programs for 1986-90," *Survey of Current Business*, Bureau of Economic Analysis, U.S. Dept. of Commerce, Vol. 64, No. 5, pp. 31-35, April.

Webb, Alan J., Michael Lopez, and Renata Penn (1990). *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*. SB-803. Economic Research Service, U.S. Dept. of Agriculture, April.

Whalley, John, and Randall Wigle (1988). *Endogenous Participation in Agricultural Support Programs and ad Valorem Equivalent Modeling*. NBER Working Paper Series No. 2583. National Bureau of Economic Research, Cambridge, MA.

Whalley, John and Yeung, Bernard (1984). "External Sector 'Closing' Rules in Applied General Equilibrium Models," *Journal of International Economics*, Vol. 16, No. 1/2, February.

APPENDIX I. FPGE GAMS Farm Programs Model

```
$TITLE FPGE U.S. CGE model: Farm Policy in General Equilibrium

$ontext
    Version 1/20/91

WRITTEN BY MAUREEN KILKENNY, (814) 865-1106,
               Dept. of Economics, Penn State Univ
               BITNET: MRK5 @ PSUVM
$offtext

SETS
I   SECTOR OR COMMODITY /   DAIRY      MILK
                            LVSTK      MEAT POULTRY EGGS
                            COTTON     COTTON
                            FOODGRN    WHEAT RICE RYE
                            FEEDCRP    CORN OATS BARLEY SORGHUM ETC
                            OILCROP    SOYBEANS PEANUTS OILSEEDS
                            SUGAR      BEET AND CANE SUGAR
                            OTHCROP    TOBACCO FRUIT VEGES FORESTRY
                            MEATMNF    PROCESEED MEAT
                            DAIRYMN    BUTTER CHEESE DRY MILK
                            GRNMILL    GRAIN MILLING
                            FEEDMNF    PREPARED FEEDS
                            CORNMIL    CORN MILLING
                            SUGARMN    SUGAR REFINING
                            SOYMILL    SOY OIL PROCESSING
                            MISCFOO    FOOD PROCESSING NEC
                            PRIMRES    STONE CLAY ETC
                            PETRO      PETROLEUM & PRODUCTS
                            CONSTRU    CONSTRUCTION
                            CHEM-RU    CHEMICAL & RUBBER
                            OTHNDUR    NONDURABLE MNF NEC
                            OTHDURM    DURABLE MNF NEC
                            METALMN    METAL MANUF
                            MACHINR    MACHINERY
                            OTH-ELE    ELECTRICAL NEC
                            CON-ELE    COMMUNICATIONS EQUIP
                            TRNS-EQ    VEHICLES & TRANS EQUIP
                            TRD-TRN    TRADE & TRANSPORT SERVICES
                            FINANCE    FINANCE & REAL ESTATE
                            SERVICE    SERVICE NEC          /

F   PRIMARY FACTORS /   LABOR     HIRED & SELF-EMPLOYED    (10000 FTE)
                        CAPITAL   PRIVATE CAPITAL          (BIL 82$)
                        LAND      AGRICULTURAL CROP LAND   (MIL ACRES) /

INS INSTITUTIONS  /     farmL     ag labor income
                        farmK     ag capital income
                        farmT     cropland rents
                        salary    non ag labor income
                        ent       non ag capital income & net FY row
                        foreign   remittances
                        welfare   transfer income /
```

```
HH   HOUSEHOLDS    /          farm          farm households
                              poor          lowest twenty percent
                              median        mid sixty percent
                              wealthy       upper twenty percent /

FM(f)          MOBILE FACTORS       / LABOR, CAPITAL /
fmn(f)         immobile factors     / land /

IAG(i)         AG SECTORS  / DAIRY, LVSTK, COTTON, FOODGRN, FEEDCRP,
                             OILCROP, SUGAR, OTHCROP /
inag(i)        non agricultural sectors

IE(i)          EXPORT SECTORS
iel(i)         export mkts where US is large
ies(i)         export mkts where US is small
   ien(i)         not exportable

   IM(i)          IMPORT SECTORS
   imn(i)           not importable

   IQ(i)          QUOTA SECTORS
   iqn(i)           no quotas

   IP(i)          DOMESTIC FARM PROGRAMS PIE
   ipn(i)           no domestic farm programs
   IT(i)          DEFICIENCY PAYMENT PROGRAM SECTOR
   itn(i)           no deficiency payments
   IF(i)          COMMODITIES FORFEITABLE TO CCC
   ifn(i)           not forfeitable
   IL(i)          COMMODITIES ELIGIBLE FOR LOAN
   iln(i)           not eligible for loan program
   IEP(i)         EXPORT ENHANCEMENT PROGRAM SECTOR
   iepn(i)          no eep programs

   IS(i)          SERVICE SECTOR / SERVICE /
   isn(i)           non service sectors

   ALIAS(I,J) ;

   ALIAS(F,K) ;

   SET ACC    SAM ACCOUNTS/COMMDTY,ACTIVITY,FACTORS,INST,HHOLDS,
                             GOVT,CCC,KACCT,WORLD,TOTALS /
      totas(acc)             / TOTALS /
      row(acc) ;
      row(acc) = NOT tots(acc) ;

   ALIAS(row,col);
PARAMETER SAM(acc,acc) SOCIAL ACCOUNTING MATRIX ;

*##########################################################################################

SCALARS
* FOREIGN TRANSACTIONS ARE IN FOREIGN CURRENCY TERMS

EXR0            DIRECT QUOTE EXCHANGE RATE                      /     1.03854505    /
```

```
ENTSAV0      TOTAL ENTERPRISE SAVINGS                          /   83.0902715    /
ENTTAX0      CORPORATE PROFIT TAX  SCB T3.1  L3                /  102.82320300   /
EROW         FACTOR INCOME RECVD  SCB T4.1 L7                  /   83.81451800   /
FBOR         OFFICIAL CAP IN   SCB T4.1 L20+21                 /  -35.12319100   /
FSAV0        NET FOREIGN SAVING IN  SCB T4.1 L22               /  130.48793400   /
FRETAX0      FARM PROPERTY TAX   ECIFS T5                      /    3.92803878   /
GDTOT0       GOVT DEMAND (SCB T1.1 L18)                        /  862.59923600   /
GENT0        GOVT TRANSFERS TO ENT                             /   85.934192     /
GOVSAV0      GOVT BUDGET SCB T3.1 L23 OR T5.1 L11              / -144.431062     /
HHSAV0       TOTAL HOUSEHOLD SAVINGS  SCB T5.1 L2              /  124.764187     /
HHTAX0       TOTAL HH TAX REVENUE  SCB T3.1 L2                 /  512.244987     /
HHT0         GOVT TRANSFERS TO HH  SCB T3.1 L11                /  496.800000     /
INVEST0      GROSS NOMINAL INVESTMENT SCB T5.2 L1              /  657.911691     /
MROW         FACTOR INCOME PAID  SCB T4.1 L16                  /   50.712114     /
PINDEX0      GNP DEFLATOR  (SCB T7.4  L1)                      /    1.15077056   /
REMIT        REMITTANCES RECVD  SCB T4.1 L19                   /   -1.828330     /
SSTAX0       TOTAL SOC SEC REVENUE  SCB T3.1  L5               /  378.125200     /

* FARM PROGRAM SCALARS ##################################################################
CURSUR       CURRENT SURPLUS  SCB T3.19  L15                          / 5.6   /
DEFPAYTOT    TOTAL DEFICIENCY PAYMENTS  US STAT ABS T1082             /12.056 /
DPAYTOT      INITIAL DIRECT PAYMENTS  SCB T3.19 L14                   /11.800/
FORTOT       STORAGE PAYMENTS   US STAT ABS 1988 T1082                / 0.342/
LMFATOT      TOTAL COMMODITY LOANS  US STAT ABS 1988 T1081            /17.390 /
NIP          NET INTEREST PAID CCC LOANS CCC MID-S-REVIEW             / 1.385 /
SUBLCS       SUBSIDIES LESS CURRENT SURPLUS SCB T3.19 L13             /17.400 /
     ;

PARAMETERS

* INITIAL DATA #########################################################################
DEP0(I)          DEPRECIATION
DST0(I)          INVENTORY INVESTMENT
E0(i)            INITIAL EXPORTS
GD0(I)           GOVERNMENT CONSUMPTION
HTAX(HH)         HOUSEHOLD TAX
ITAX(I)          INDIRECT TAX
KISH(I)          INVESTMENT BY SECTOR OF DESTINATION
M0(i)            INITIAL IMPORTS
PD0(i)           INITIAL DOMESTIC GOODS PRICE
PE0(i)           INITIAL DOMESTIC PRICE OF EXPORTS
PM0(i)           INITIAL DOMESTIC PRICE OF IMPORTS
P0(i)            INITIAL PRICE OF COMPOSITE GOOD
PX0(i)           INITIAL AVERAGE OUTPUT PRICE
TM0(I)           TARIFFS
TMREAL(i)        REAL TARIFF RATE WRT 1982
XD0(i)           INITIAL DOMESTIC OUTPUT
YINST0(ins)      INITIAL INSTITUTIONAL INCOME DISTRIBUTIONS

* CALCLATED PARAMETERS ################################################################
DEPR(I)          DEPRECIATION RATE WRT CAPITAL EMPLOYED
DSTR(I)          INVENTORY ACCUMULATION WRT OUTPUT
ESR              ENTERPRISE SAVINGS RATE
ETR              ENTERPRISE TAX RATE
FRETR            FARM REAL ESTATE TAX RATE
FS0(i,f)         INITIAL TOTAL FACTOR SUPPLY
```

WFDIST0(i,f)	INITIAL RATIO OF SECTOR TO AVERAGE FACTOR PRICE
FY0(f)	INITIAL AGGREGATE FACTOR INCOME
GLES(I)	GOVT CONSUMPTION SHARES
INT0(i)	INITIAL INTERMEDIATE INPUT USE
PK0(i)	INITIAL COMPOSITE CAPITAL GOODS PRICE
PVA0(i)	INITIAL VALUE ADDED RATE NET OF ITAX GROSS OF SUBSIDIES
PWM0(i)	INITIAL BORDER PRICE OF IMPORTS
PWE0(i)	INITIAL BORDER PRICE OF EXPORTS
PWSE(i)	INITIAL WORLD PRICE OF EXPORT SUBSTITUTES
SSTR	SOCIAL SECURITY TAX RATE
VAR0(i)	INITIAL VALUE ADDED RATE GROSS OF ITAX NET OF SUBSIDY
WF0(f)	INITIAL AGGREGATE AVERAGE FACTOR PRICE
XXD0(i)	INITIAL DOMESTIC SALES
XS0(i)	INITIAL SUPPLY EQUALS DOMESTIC OUTPUT LESS STOCKS
X0(i)	INITIAL COMPOSITE GOOD DEMAND
YH0(hh)	INITIAL HOUSEHOLD INCOME
WALRAS	EXCESS INVESTMENT OVER SAVINGS

* ### SECTORAL FARM PROGRAM DATA (via FARMDATA.GMS) ##################################

ARP0(i)	INITIAL ACREAGE REDUCTION
ASSMNT(i)	FEES LICENSES ETC
DEFPAY0(i)	INITIAL DEFICIENCY PAYMENTS
EEPN0(i)	INITIAL EXPORT ENHANCEMENT EXPENDITURES NOMINAL AT PX
LMFA0(i)	INITIAL LOANS AT PL
PL0(i)	INITIAL LOAN RATE
TP0(i)	INITIAL TARGET PRICE
PGAP0(i)	INITIAL TP OVER PX GAP
XF0(i)	INITIAL QUANTITY OUTPUT FORFEITED
XL0(i)	INITIAL QUANTITY OUTPUT AS LOAN COLLATERAL
XP0(i)	INITIAL QUANTITY OUTPUT UNDER PROGRAM

* CALCLATED FARM PROGRAM PARAMETERS ###

CCCE0	INITIAL CCC STOCKING COSTS AT PX
CCCIVA	INITIAL CCC INVENTORY VALUATION ADJUSTMENT
DIRPAY	TOTAL DIRECT NON-DISTORTING PAYMENTS NET OF ASSMNTS
FPE0	INITIAL NET FARM PROGRAM OUTLAYS INCLUDING STOCK COST
LFB0(i)	INITIAL LOAN FORFEIT BENEFIT
LSB0(i)	INTEREST SUBSIDY ON LOANS MADE AT FACE AMOUNT
LSBR(i)	INTEREST SUBSIDY RATE PER DOLLAR LOANED
PREMIUM0(i)	INITIAL QUOTA PREMIUM RECEIVED DOMESTICALLY
PIE0(i)	PRODUCER INCENTIVE EQUIVALENT RATE PER UNIT OUTPUT
TMQ0(i)	INITIAL RATE OF PREMIUM OVER PWM FOR QUOTA IMPORTS
XF00(I)	TRUE CONSTANT IN COMMODITY FORFEIT EQUATION XFEQ

* ASSUMED AND CALBRATED BEHAVIORAL PARAMETERS #####################################

AC(i)	CES FUNCTION SHIFT PARAMETER
AD(i)	PRODUCTION FUNCTION SHIFT PARAMETER
ALPHA(i,f)	FACTOR SHARE PARAMETER IN PRODUCTION FUNCTION
AT(i)	CET FUNCTION SHIFT PARAMETER
CPCTY(i)	CAPACITY UTILIZATION RATE
DELTA(i)	CES FUNCTION SHARE PARAMETER
ECONST(i)	ROW IMPORT DEMAND CONSTANT
GAMMA(i)	CET FUNCTION SHARE PARAMETER
OMEGA(i)	QUOTA RENT DOMESTIC RETENTION RATE
EELAS(i)	EEP PROVISION ELASTICITY

FELAS(i)	FORFEITS AND STOCKING ELASTICITY
LELAS(i)	LOAN PARICIPATION ELASTICITY
PCON(i)	PARTICIPATION CONSTANT
RMD(i)	RATIO OF IMPORTS TO DOMESTIC SALES
RHOC(i)	CES FUNCTION EXPONENT
RHOE(i)	EXPORT DEMAND PRICE ELASTICITY
RHOT(i)	CET FUNCTION EXPONENT
SIGMA(i)	ELASTICITY OF SUBST BETWEEN IMPORTS AND DOMESTIC GOODS
SUMSHI(i)	HOLD FOR SUM OVER I

;

*###### PARAMETER ASSIGNMENT ##

* THE NEXT SIX TABLES CAN BE INSERTED FROM MODEL SOLUTION DISPLAY

TABLE SECTRES(*,I) ENDOGENOUS SECTORAL Q AND P

	DAIRY	LVSTK	COTTON	FOODGRN	FEEDCRP
E		0.51661441	0.82375560	3.75830529	3.89337485
M		1.48598531	0.00369998	0.12043445	0.22816508
P	0.92689207	0.98140607	1.00127405	0.82230452	0.83153209
PD	0.92689207	0.98159807	1.00124505	0.82390954	0.83149609
PE	1.00000000	0.93211604	0.95976081	0.74115515	0.79626304
PM	1.00000000	0.97289105	1.02038005	0.77016204	0.84246904
PX	0.92689207	0.98120407	0.99031026	0.78168633	0.82868908
XD	20.34018292	65.87776232	3.14160509	8.51978722	52.28127503

+ (Table Sectres is truncated here)

;

TABLE SRATE (*,I) EXOGENOUS SECTORAL RATES

* note that GD includes XF here:

	DAIRY	LVSTK	COTTON	FOODGRN	FEEDCRP
ITAX	0.31053516	1.17659907	0.03789194	0.12724397	0.83968607
KISH	0.00299500	0.00961399	0.00098500	0.00136700	0.00607299
TM		0.01372402		0.00118800	0.00121600
TMREAL		0.01398100		0.06628800	0.00808200
GD	0.45354197	0.17862699	0.10197478	1.78806198	6.40377464
DST	0.01769601	-0.03432203	0.02606198	-0.04276097	0.03204800
DEP	2.02341574	6.06052255	0.51787444	0.46305861	4.02987429

+ (truncated) ;

TABLE PROGRAM(*,I) FARM PROGRAM DATA

* read in directly from FARMDATA listing, except for PREMIUM

	DAIRY	COTTON	SUGAR	LVSTK	FOODGRN
ASSMNT	0.28742000				
ARP		3.30000000			21.10000000
DEFPAY		1.02093102			4.01220012
LMFA		1.95780000	0.96720000		2.34420000
XF		0.14000388			1.20636624
XL		2.07501970	0.95030263		2.56566244
XP		2.36854615			6.58748538

EEP				0.05317000	0.12850000
PREMIUM			0.00013600		

+	FEEDCRP	OILCROP	OTHCROP	DAIRYMN	GRNMILL
ARP	31.40000000				
DEFPAY	7.02286886				
LMFA	8.88930000	2.79070000	0.44130000		
XF	6.95797753	0.73286455		2.03443948	
XL	7.68983714	3.18072331	0.45436713		
XP3	33.25585651				
EEP	0.02840000				0.05850000
PREMIUM				0.35300352	

+	SOYMILL
EEP	0.00099000

;

TABLE FYS0(I,F) INITIAL VALUE ADDED TO PRIMARY FACTORS

	LABOR	CAPITAL	LAND
DAIRY	2.652913	4.955870	
LVSTK	4.960968	7.156504	
COTTON	1.178815	0.666081	0.544975
FOODGRN	2.698680	0.648250	3.673414
FEEDCRP	9.771187	5.289173	9.822751
OILCROP	2.272777	1.655197	3.073935
SUGAR	0.433874	0.422696	0.181156
OTHCROP	8.482909	5.998190	1.999397
MEATMNF	9.363359	6.027973	
DAIRYMN	5.289493	3.389079	
GRNMILL	2.266339	1.429886	
FEEDMNF	1.894641	1.218928	
CORNMIL	0.420966	0.255456	
SUGARMN	2.394515	1.524336	
SOYMILL	2.031824	1.297655	
MISCFOO	17.983040	4.219657	
PRIMRES	22.859576	12.397619	
PETRO	27.729773	59.073034	
CONSTRU	148.940017	49.676900	
CHEM-RU	61.680863	31.673589	
OTHNDUR	97.812767	38.778301	
OTHDURM	52.863150	21.524836	
METALMN	71.502087	17.368618	
MACHINR	72.701127	8.617352	
OTH-ELE	67.080114	9.029701	
CON-ELE	24.319733	3.636109	
TRNS-EQ	84.641300	13.836904	
TRD-TRN	518.793855	205.718968	
FINANCE	186.498105	410.255619	
SERVICE	1098.539645	305.423726	

;

TABLE EMPL0(I,F) FACTOR DEMAND BY SECTOR

	LABOR	CAPITAL	LAND
DAIRY	21.336997	11.608201	
LVSTK	50.401191	34.606101	
COTTON	2.886897	3.097279	8.467992
FOODGRN	10.479600	8.677001	63.744999
FEEDCRP	34.837698	51.531707	171.127995
OILCROP	12.926101	15.424704	63.754006
SUGAR	3.848693	1.847097	1.987996
OTHCROP	66.582793	20.808002	11.860999
MEATMNF	36.470697	15.485001	
DAIRYMN	15.932001	8.602002	
GRNMILL	5.258199	4.032000	
FEEDMNF	4.306300	3.302000	
CORNMIL	0.965801	0.741001	
SUGARMN	9.405599	3.336000	
SOYMILL	4.633900	3.553000	
MISCFOO	80.427599	26.248004	
PRIMRES	125.400011	62.800017	
PETRO	62.399998	274.200044	
CONSTRU	604.300105	50.800019	
CHEM-RU	179.499995	110.300018	
OTHNDUR	407.299995	108.600018	
OTHDURM	223.700027	51.800016	
METALMN	215.800015	125.000032	
MACHINR	205.700018	81.400022	
OTH-ELE	201.700015	66.000017	
CON-ELE	78.200008	25.600007	
TRNS-EQ	201.800011	78.700018	
TRD-TRN	2544.699910	662.400100	
FINANCE	666.599944	3952.000399	
SERVICE	4405.299883	1079.000172	

;

TABLE CDHH(I,HH) HOUSEHOLD CONSUMPTION LEVELS
* USE LEVELS IF CHANGING INITIAL HOUSEHOLD INCOME LEVELS
* USE SHARES IF NO CHANGE IN INCOME LEVELS
* CLES HOUSEHOLD CONSUMPTION NOMINAL SHARES

	FARM	POOR	MEDIAN	WEALTHY
DAIRY	0.00091300	0.00107200	0.00139352	0.00075400
LVSTK	0.00141100	0.00164101	0.00201485	0.00118100
COTTON	0.00000400	0.00000400	0.00000398	0.00000400
FOODGRN	0.00000700	0.00000700	0.00000618	0.00000700
FEEDCRP	0.00030050	0.00029300	0.00020795	0.00030800
OILCROP	0.00003400	0.00003400	0.00003228	0.00003400
SUGAR	0.00000200	0.00000200	0.00000199	0.00000200
OTHCROP	0.00445101	0.00472502	0.00540863	0.00417700
MEATMNF	0.01397903	0.01594706	0.01826840	0.01201101
DAIRYMN	0.00781552	0.00891604	0.01021450	0.00671501
GRNMILL	0.00371351	0.00423602	0.00485248	0.00319100
FEEDMNF	0.00014900	0.00017000	0.00019488	0.00012800
CORNMIL	0.00008700	0.00009900	0.00011389	0.00007500

```
SUGARMN     0.00046000   0.00052500   0.00060159   0.00039500
SOYMILL     0.00074900   0.00085400   0.00097837   0.00064400
MISCFOO     0.03695359   0.04215617   0.04829278   0.03175103
PRIMRES     0.00047400   0.00047300   0.00050304   0.00047500
PETRO       0.01280103   0.01435606   0.01356883   0.01124601
CHEM-RU     0.01476304   0.01570506   0.01730074   0.01382101
OTHNDUR     0.05801815   0.05744923   0.05510233   0.05858706
OTHDURM     0.01552754   0.01498706   0.01137096   0.01606802
METALMN     0.00180900   0.00169201   0.00145111   0.00192600
MACHINR     0.00063800   0.00063000   0.00059565   0.00064600
OTH-ELE     0.00313951   0.00301401   0.00290305   0.00326500
CON-ELE     0.01719004   0.01756507   0.01700212   0.01681502
TRNS-EQ     0.03717309   0.03474814   0.02173843   0.03959804
TRD-TRN     0.17833345   0.17884271   0.18027750   0.17782417
FINANCE     0.24474612   0.23096290   0.20905538   0.25852925
SERVICE     0.34435787   0.34889345   0.37654459   0.33982235
     ;

* READ PARAMETER VALUES FROM WILDCARD TABLES ########################################

E0(i)            = SECTRES("E",i) ;
M0(i)            = SECTRES("M",i) ;
P0(i)            = SECTRES("P",i) ;
PD0(i)           = SECTRES("PD",i) ;
PE0(i)           = SECTRES("PE",i) ;
PM0(i)           = SECTRES("PM",i) ;
PX0(i)           = SECTRES("PX",i) ;
XD0(i)           = SECTRES("XD",i);

ECONST(i)        = E0(i) ;

DEP0(I)          = SRATE("DEP",I) ;
DST0(I)          = SRATE("DST",I) ;
DSTR(I)          = DST0(I)/XD0(I) ;
GD0(I)           = SRATE("GD",I) ;
ITAX(i)          = SRATE("ITAX",i)/(PX0(i)*XD0(i)) ;
KISH(i)          = SRATE("KISH",i) ;
   KISH(I)       = KISH(I)/SUM(J,KISH(J)) ;
TM0(i)           = SRATE("TM",I) ;
TMREAL(i)        = SRATE("TMREAL",I) ;

ARP0(i)          = PROGRAM("ARP",i) ;
ASSMNT("dairy")  = .28742 ;
DEFPAY0(I)       = PROGRAM("DEFPAY",I) ;
EEPN0(I)         = PROGRAM("EEP",I) ;
LMFA0(I)         = PROGRAM("LMFA",I) ;
PREMIUM0(I)      = PROGRAM("PREMIUM",I) ;
XF0(I)           = PROGRAM("XF",I) ;
XL0(I)           = PROGRAM("XL",I) ;
XP0(I)           = PROGRAM("XP",I) ;

VAR0(i)          = SUM(f, FYS0(i,f)) ;
FYS0(i,f)        = FYS0(i,f)/VAR0(i) ;

* ########### CON'T EXOGENOUS PARAMETER ASSIGNMENT ###################################
* since these are exogenous, no need to read in from solution(s)
```

TABLE HHPAR(HH,*) HOUSEHOLD PARAMETERS

	HTAX	MPS
FARM	.00010	.017538
POOR	.03701	.000000
MEDIAN	.32907	.432261
WEALTHY	.63382	.550201

;

HTAX(hh) = HHPAR(hh,"HTAX")*HHTAX0 ;

TABLE SINTYH(HH,INS) DISTRIBUTION OF INCOME FLOWS TO HOUSEHOLDS

	FARML	FARMK	FARMT	SALARY	ENT	FOREIGN	WELFARE
FARM	1.0	1.0	.75	.013	.013	.00	.015
POOR	0.0	0.0	.08	.064	.182	.20	.319
MEDIAN	0.0	0.0	.06	.386	.292	.35	.417
WEALTHY	0.0	0.0	.11	.537	.513	.45	.249

;

TABLE ELASTICITY(*,I) BEHAVIORAL ELASTICITIES

	DAIRY	LVSTK	COTTON	FOODGRN	FEEDCRP
OMEGA	0.000000				
SIGMA	2.000000	2.000000	4.00000	4.000000	4.000000
RHOT	2.000000	2.000000	4.000000	4.000000	4.000000
RHOE	0.000000	0.000000	3.000000	3.000000	3.000000
EELAS	4.0	4.0	4.0	4.0	4.0
FELAS	6.0	6.0	3.0	3.0	3.0
LELAS	4.0	4.0	4.0	4.0	4.0

+	OILCROP	SUGAR	OTHCROP	MEATMNF	DAIRYMN
OMEGA		0.500000			0.500000
SIGMA	3.000000	0.500000	0.500000	1.730000	1.730000
RHOT	4.000000	2.000000	2.000000	2.000000	2.000000
RHOE	3.000000	0.000000	0.000000	0.000000	0.000000
EELAS	4.0				4.0
FELAS	3.0	3.0	3.0		9.0
LELAS	4.0				4.0

+	GRNMILL	FEEDMNF	CORNMIL	SUGARMN	SOYMILL
SIGMA	1.730000	1.730000	1.730000	5.000000	4.000000
RHOT	3.000000	3.000000	3.000000	2.000000	3.000000
RHOE	0.000000	0.000000	0.000000	0.000000	0.000000
EELAS	4.0	4.0			4.0

+	MISCFOO	PRIMRES	PETRO	CONSTRU	CHEM-RU
SIGMA	1.730000	2.000000	0.755000	0.750000	0.670000
RHOT	2.000000	2.000000	2.000000	2.000000	2.000000

+	OTHNDUR	OTHDURM	METALMN	MACHINR	OTH-ELE
SIGMA	0.670000	1.280000	1.280000	1.280000	1.280000
RHOT	2.000000	2.000000	2.000000	2.000000	2.000000

+	CON-ELE	TRNS-EQ	TRD-TRN	FINANCE	SERVICE
SIGMA	1.280000	2.866000	1.200000	1.200000	1.200000
RHOT	2.000000	2.000000	2.000000	2.000000	2.000000

;

```
OMEGA(i)    = ELASTICITY("OMEGA",i);
RHOE(i)     = ELASTICITY("RHOE",i);
SIGMA(i)    = ELASTICITY("SIGMA",I);
RHOC(i)     = (1/SIGMA(i)) - 1;
RHOT(i)     = (1/ELASTICITY("RHOT",i)) + 1;
EELAS(i)    = ELASTICITY("EELAS",i);
FELAS(i)    = ELASTICITY("FELAS",i);
LELAS(i)    = ELASTICITY("LELAS",i);
```

TABLE IO(I,J) INPUT-OUTPUT COEFFICIENTS

	DAIRY	LVSTK	COTTON	FOODGRN	FEEDCRP
DAIRY	0.000097	0.002531	0.001693	0.000767	0.009950
LVSTK	0.001122	0.225113	0.040111	0.032633	0.033989
COTTON	0.000085	0.000173	0.007907	0.000210	0.000143
FOODGRN	0.000535	0.001449	0.002821	0.036293	0.000343
FEEDCRP	0.343633	0.307409	0.012097	0.002132	0.058530
OILCROP	0.000110	0.000512	0.001545	0.000272	0.000186
SUGAR	0.000014	0.000029	0.000203	0.000036	0.000024
OTHCROP	0.000384	0.001019	0.005386	0.000953	0.003932
MEATMNF	0.000016	0.000087	0.000001	0.000003	0.000003
DAIRYMN	0.000238	0.000261	0.000005	0.000007	0.000013
GRNMILL	0.001047	0.001363	0.000001	0.000001	0.000001
FEEDMNF	0.128825	0.141218	0.000229	0.000302	0.000367
CORNMIL	0.000476	0.000402	0.000002	0.000002	0.000006
SUGARMN	0.002187	0.002457	0.000002	0.000002	0.000005
SOYMILL	0.004576	0.014228	0.000001	0.000002	0.000003
MISCFOO	0.000347	0.000364	0.000088	0.000086	0.000108
PRIMRES	0.000026	0.000262	0.001610	0.003596	0.004126
PETRO	0.006543	0.008974	0.045484	0.081477	0.067268
CONSTRU	0.003796	0.003358	0.009213	0.009842	0.009130
CHEM-RU	0.006156	0.008232	0.089287	0.087850	0.110910
OTHNDUR	0.000707	0.002943	0.000381	0.000367	0.002068
OTHDURM	0.000369	0.000239	0.001406	0.001071	0.001129
METALMN	0.001383	0.000991	0.001650	0.001873	0.002566
MACHINR	0.005031	0.010544	0.018454	0.024720	0.020555
OTH-ELE	0.000050	0.000084	0.000134	0.000129	0.000106
CON-ELE	0.000427	0.000847	0.003251	0.003981	0.004271
TRNS-EQ	0.000525	0.001082	0.001240	0.001771	0.001117
TRD-TRN	0.045881	0.058525	0.079572	0.092546	0.098764
FINANCE	0.014866	0.017658	0.104149	0.090487	0.064691
SERVICE	0.012313	0.022861	0.109969	0.035188	0.034646

```
     +          OILCROP         SUGAR       OTHCROP      MEATMNF      DAIRYMN
                (truncated)          ;

TABLE IMAT(I,J) CAPITAL COMPOSITION MATRIX

                DAIRY         LVSTK        COTTON      FOODGRN      FEEDCRP

CONSTRU        0.738077      0.738077     0.387261     0.387261     0.387261
CHEM-RU        0.000000      0.000000     0.000000     0.000000     0.000000
OTHNDUR        0.000028      0.000028     0.000000     0.000000     0.000000
OTHDURM        0.001125      0.001125     0.000023     0.000023     0.000023
METALMN        0.006420      0.006420     0.003606     0.003606     0.003606
MACHINR        0.130383      0.130383     0.577085     0.577085     0.577085
OTH-ELE        0.017622      0.017622     0.004825     0.004825     0.004825
CON-ELE        0.004084      0.004084     0.000016     0.000016     0.000016
TRNS-EQ        0.102260      0.102260     0.027184     0.02718      0.027184

     +          OILCROP         SUGAR       OTHCROP      MEATMNF      DAIRYMN
     (truncated)         ;

SUMSHI(j)      =  SUM(i, IMAT(i,j)) ;
IMAT(i,j)      =  IMAT(i,j)/SUMSHI(j) ;
SUMSHI(j)      =  0.0 ;

*########################## SUBSETS ############################################################
INAG(i)        =  NOT IAG(i)          ;
IE(i)          =  YES$E0(i)           ;
IEL(i)         =  YES$RHOE(i)         ;
IEN(i)         =  NOT IE(i)           ;
IES(i)         =  IE(i) - IEL(i)      ;
IM(i)          =  YES$M0(i)           ;
IMN(i)         =  NOT IM(i)           ;
IQ(i)          =  YES$OMEGA(i)        ;
IQN(i)         =  NOT IQ(i)           ;
ISN(i)         =  NOT IS(i)           ;

IT(i)          =  yes$DEFPAY0(i)      ;
ITN(i)         =  not IT(i)           ;
IF(i)          =  YES$XF0(i)          ;
IFN(i)         =  NOT IF(i)           ;
IL(i)          =  yes$XL0(i)          ;
ILN(i)         =  not IL(i)           ;
IP(i)          =  IT(i) + IF(i) + IL(i) ;
IP("dairy")    =  yes                 ;
IPN(i)         =  NOT IP(i)           ;
IEP(i)         =  YES$EEPN0(i)        ;
IEPN(i)        =  NOT IEP(i)          ;

* DISPLAY IEL,IES,IMN,IQ,IT,IF,IL,IP,IEP ;

*################### CALCULATED PARAMETERS ###############################################
$ONTEXT
*OFF $ONTEXT IF DATA IN DOLLAR TERMS; ON IF SOLUTION IS USED
  REMIT        =  REMIT/EXR0          ;
  EROW         =  EROW/EXR0           ;
  MROW         =  MROW/EXR0           ;
```

```
  FSAV0         = FSAV0/EXR0          ;
  FBOR          = FBOR/EXR0           ;
$OFFTEXT

  INT0(i)       = sum(j, IO(i,j)*XD0(j));
  XS0(i)        = XD0(i) - XF0(i) ;
  XXD0(i)       = (XS0(i)*PX0(i) - E0(i)*PE0(i)) / PD0(i) ;
  X0(i)         = (PD0(i)*XXD0(i) + PM0(i)*M0(i)) / P0(i) ;

  PK0(i)        = SUM(j, P0(j)*IMAT(j,i)) ;

*###### CALCULATED FARM PROGRAM PARAMETERS ###########################################
  PWM0(IM)      = (PM0(IM)*M0(IM)-TM0(IM)-PREMIUM0(IM))/(EXR0*M0(IM));
  TMQ0(IQ)      = PREMIUM0(IQ)/(PWM0(IQ)*M0(IQ)*EXR0) ;
  TM0(IM)       = TM0(IM)/(PWM0(IM)*M0(IM)*EXR0) ;

  PWE0(IE)      = PE0(IE)/(EXR0*(1+(EEPN0(IE)
                  /((PE0(IE)*E0(IE))-EEPN0(IE))))) ;
  PWSE(i)       = PWE0(i) ;

  FSAV0         = SUM(I,PWM0(i)*M0(i)-PWE0(i)*E0(i))-REMIT-FBOR-(EROW-MROW);

* isolating Gov't nonprogram purchases of commodities
  GD0(I)        = GD0(I) - XF0(I) ;
  GDTOT0        = SUM(I,GD0(I)*P0(I));
  GLES(I)       = (GD0(I)*P0(I)) / GDTOT0 ;

* total market value of gross forfeits
  CCCE0         = SUM(i, PX0(i)*XF0(i)) ;

* reconciling deficiency payments with total
  SUMSHI(i)     = DEFPAY0(i)/SUM(j,DEFPAY0(j)) ;
  DEFPAY0(i)    = SUMSHI(i)*DEFPAYTOT ;
  SUMSHI(i)     = 0.0 ;

* calculate other direct payments as residual
  DIRPAY        = SUBLCS + SUM(i,ASSMNT(i))-DEFPAYTOT-CURSUR ;

* calibrate LFB and LSB w.r.t. data on LMFA, NIP.
  PL0(i)             = PX0(i) ;
  PL0(i)$XL0(i)      = LMFA0(i)/XL0(i) ;
  CCCIVA             = CURSUR - SUM(I,EEPN0(I)) - NIP - FORTOT ;
  LFB0(I)            = (PL0(I)-PX0(I))*XF0(I) ;
  SUMSHI(i)          = LFB0(i)/SUM(j,LFB0(j)) ;
  LFB0(i)            = SUMSHI(i)*CCCIVA ;
  SUMSHI(i)          = 0.0 ;

  SUMSHI(i)          = LMFA0(i)/SUM(j,LMFA0(j)) ;
  LSB0(i)            = SUMSHI(i)*NIP   ;
  SUMSHI(i)          = 0.0 ;

* calibrate transaction loan rates PL, and XL
  PL0(i)$XF0(i)      = PX0(i) + LFB0(i)/XF0(i)  ;
  XL0(I)$PL0(I)      = LMFA0(I)/PL0(I) ;
* calibrate forfeits equation parameter w.r.t. calibrated PL
  XF00(I)            = XF0(I)-(XF0(i)*((PL0(I)/PX0(I))**FELAS(I))) ;
```

```
* calibrate LSBR w.r.t. calibrated XL
  LSBR(i)            =  0.0 ;
  LSBR(i)$XL0(i)     =  LSB0(i)/XL0(i)  ;

* calibrate target prices w.r.t. PL and DEFPAY
  TP0(i)             =  PX0(i) ;
  TP0(i)$XP0(i)      =  PL0(i) + DEFPAY0(i)/XP0(i) ;
  PGAP0(i)           =  TP0(i) - PX0(i) ;

* initialize PIE and FPE
  PIE0(I)            =  (DEFPAY0(I) + LFB0(I) - ASSMNT(I))/XD0(I);
  FPE0               =  CCCE0 + DIRPAY + FORTOT
                        + SUM(I,DEFPAY0(I)+LSB0(I)+LFB0(I)+EEPN0(I)-ASSMNT(I)) ;

* net farm progran transfers out of total Gov't transfers to ENT
  GENT0              =  GENT0 - FPE0 + CCCE0 ;

* introduce the PIE's into the PVA and WFDIST equations
  PVA0(i)            =  PIE0(i)+PX0(i)*(1.0-ITAX(i))-SUM(j,IO(j,i)*P0(j));
  VAR0(i)            =  PVA0(i)*XD0(i) ;
  FYS0(i,f)          =  FYS0(i,f)*VAR0(i) ;
  FY0(f)             =  SUM(i,FYS0(i,f)) ;
  WF0(f)             =  FY0(f)/SUM(i,EMPL0(i,f)) ;
  WFDIST0(i,f)$EMPL0(i,f) = (FYS0(i,f)/EMPL0(i,f))/WF0(f);
  WFDIST0(i,f)$(EMPL0(i,f) EQ 0) = 0.0 ;

*##################### CALIBRATION ############################################################

  ALPHA(i,f)   =  FYS0(i,f)/VAR0(i) ;
  AD(i)        =  XD0(i)/PROD(F,EMPL0(i,f)**ALPHA(i,f)) ;

  RMD(im)      =  M0(im)/XXD0(im) ;
  DELTA(im)    =  (PM0(im)/PD0(im))*RMD(im)**(1+RHOC(im));
  DELTA(im)    =  DELTA(im)/(1.0+DELTA(im));
  AC(im)       =  X0(im)/(DELTA(im)*M0(im)**(-RHOC(im))
                  +  (1-DELTA(im))*XXD0(im)**(-RHOC(im)))**(-1/RHOC(im)) ;

  GAMMA(ie)    =  1/(1 + PD0(ie)/PE0(ie)*(E0(ie)/XXD0(ie))**(RHOT(ie)-1));
  AT(ie)       =  XS0(ie)/(GAMMA(ie)*E0(ie)**RHOT(ie) + (1-GAMMA(ie))*
                  XXD0(ie)**RHOT(ie))**(1/RHOT(ie)) ;

*############### MAP NOMINAL FLOWS ###########################################################

  VAR0(I)      =  VAR0(I)/XD0(I) + ITAX(I)*PX0(I) - PIE0(I) ;
  DEPR(I)      =  DEP0(I)/(PK0(I)*EMPL0(I,"CAPITAL")) ;
  SSTR         =  SSTAX0/FY0("labor") ;
  FRETR        =  FRETAX0/(FY0("LAND")+DIRPAY+FORTOT) ;
  ETR          =  ENTTAX0/(FY0("CAPITAL")+GENT0+(EROW-MROW)*EXR0
                  +SUM(I,LSB0(I)+PREMIUM0(I)-DEP0(I))) ;
  ESR          =  ENTSAV0/(FY0("CAPITAL")-ENTTAX0+GENT0+(EROW-MROW)*EXR0
                  +SUM(I,LSB0(I)+PREMIUM0(I)-DEP0(I))) ;

  YINST0("FARML")     =  (1-SSTR)*SUM(iag, FYS0(iag,"labor")) ;
  YINST0("FARMK")     =  (1-ESR)*(1-ETR)*SUM(IAG, FYS0(IAG,"CAPITAL")
                         +LSB0(IAG)+PREMIUM0(IAG)-DEP0(IAG)) ;
  YINST0("FARMT")     =  (1-FRETR)*(FY0("LAND")+DIRPAY+FORTOT) ;
```

```
YINST0("SALARY")    = (1-SSTR)*SUM(inag, FYS0(inag,"labor")) ;
YINST0("ENT")       = (1-ESR)*(1-ETR)*( SUM(INAG, FYS0(INAG,"CAPITAL")
                      +LSB0(INAG)+PREMIUM0(INAG)-DEP0(INAG))
                        + GENT0 + (EROW-MROW)*EXR0 ) ;
YINST0("FOREIGN")   = REMIT*EXR0 ;
YINST0("WELFARE")   = HHT0 ;
YH0(hh)             = SUM(ins, SINTYH(hh,ins)*YINST0(ins)) ;
HTAX(hh)            = HTAX(hh)/YH0(hh) ;

*################### VARIABLE DECLARATION ##########################################

POSITIVE VARIABLES

*## PRICES -- ALL NORMALIZED W.R.T. PX 1982=1.0
  EXR          REAL EXCHANGE RATE
  P(i)         PRICE OF COMPOSITE GOODS
  PD(i)        DOMESTIC PRICES
  PE(i)        DOMESTIC PRICE OF EXPORT
  PK(i)        PRICE OF CAPITAL GOOD
  PM(i)        DOMESTIC PRICE OF IMPORT
  PVA(i)       VALUE ADDED PRICE SUBSIDIZED AND TAXED
  PWE(i)       BORDER PRICE OF EXPORT
  PWM(i)       BORDER PRICE OF IMPORT
  PX(i)        AVERAGE OUTPUT PRICE
  PINDEX       GDP DEFLATOR
  TM(i)        TARIFF RATE
*## QUANTITIES
  E(i)         EXPORTS                                       (BIL 82$)
  M(i)         IMPORTS                                       (BIL 82$)
  X(i)         QUANTITY OF COMPOSITE GOOD                    (BIL 82$)
  XD(i)        PRODUCTION                                    (BIL 82$)
  XXD(i)       DOMESTIC SALES                                (BIL 82$)
  XS(i)        DOMESTIC SUPPLIES NET OF STOCKS               (BIL 82$)
  INT(i)       INTERMEDIATE INPUT DEMAND                     (BIL 82$)
  FD(i,f)      SECTORAL FACTOR DEMAND
  WF(f)        AVERAGE FACTOR PRICE
      ;
VARIABLES
  FS(i,f)      FACTOR SUPPLIES
  CD(i)        PRIVATE CONSUMPTION FINAL DEMAND              (BIL 82$)
  CLES(I,HH)   HOUSEHOLD CONSUMPTION NOMINAL SHARES
  DK(i)        DEMAND FOR THE COMPOSITE CAPITAL GOOD         (BIL 82$)
  DST(i)       SECTORAL INVENTORY INVESTMENT                 (BIL 82$)
  ID(i)        FINAL DEMAND AS INVESTMENT GOOD               (BIL 82$)
  GD(i)        GOVERNMENT FINAL DEMAND                       (BIL 82$)
*##  FARM PROGRAM VARIABLES
  ARP(I)       ACREAGE REDUCTION                             ( % )
  DEFPAY(i)    DEFICIENCY PAYMENTS                           (BIL $)
  FPE          TOTAL FARM PROGRAM EXPENDITURES               (BIL $)
  CCCE         VALUE OF CCC LOAN INVENTORY                   (BIL $)
  LFB(i)       LOAN FORFEIT BENEFIT                          (BIL $)
  LSB(i)       LOAN SUBSIDY BENEFIT                          (BIL $)
  LP(I)        PROGRAM CROPLAND                              (MIL ACRES)
  PL(I)        LOAN RATE
  TP(I)        TARGET PRICE
  PGAP(i)      TARGET PRICE MARKET PRICE GAP
```

```
  TEE(i)        EXPORT ENHANCEMENT PROGRAM SUBSIDY RATES           (BIL $)
  TMQ(i)        AD VALOREM TARIFF EQUIVALENT OF QUOTA
  PIE(i)        TOTAL DISTORTING TRANSFERS IN PVA                  (BIL $)
  PREMIUM(i)    QUOTA PREMIUM RECVD BY DOMESTIC FIRMS              (BIL $)
  EEP(i)        EXPORT SUBSIDIES IN CERTIFICATES                   (BIL $)
  XL(i)         QUANTITY OUTPUT AS LOAN COLLATERAL                 (BIL 82$)
  XF(i)         QUANTITY OUTPUT FORFEITED FOR LOAN                 (BIL 82$)
  XP(i)         QUANTITY OUTPUT UNDER PROGRAM                      (BIL 82$)
  XPR(I)        PROGRAM LAND USE AND OUTPUT RATE
*## NOMINAL TRANSACTIONS
  WFDIST(i,f)   FACTOR PRICE PROPORTIONALITY FACTOR
  FY(f)         FACTOR INCOME                                      (BIL $)
  FYS(i,f)      FACTOR INCOME BY SECTOR                            (BIL $)
  DEPRECIA      TOTAL DEPRECIATION EXPENDITURE                     (BIL $)
  ENTSAV        ENTERPRISE SAVINGS                                 (BIL $)
  ENTTAX        ENTERPRISE TAX REVENUE                             (BIL $)
  FRETAX        FARM LAND PROPERTY TAX                             (BIL $)
  FSAV          FOREIGN SAVINGS RECVD                              (BIL $)
  FXDINV        CAPITAL INVESTMENT IN FIXED K                      (BIL $)
  GENT          NONDISTORTING TRANSFERS TO NONAG ENTERPRISE        (BIL $)
  GDTOTN        NOMINAL GOVT DEMAND EXCLUDING AG STOCKS            (BIL $)
  GOVSAV        GOVERNMENT BUDGET SURPLUS OR DEFICIT               (BIL $)
  GR            GOVERNMENT REVENUE                                 (BIL $)
  HHSAV         HOUSEHOLD SAVINGS                                  (BIL $)
  HHT           GOVT TRANSFERS TO HOUSEHOLDS                       (BIL $)
  HHTAX         HOUSEHOLD TAX RVENUE                               (BIL $)
  INDTAX        INDIRECT TAX REVENUE                               (BIL $)
  INVEST        TOTAL INVESTMENT                                   (BIL $)
  MPS(hh)       HOUSEHOLD AVERAGE  PROPENSITY TO SAVE
  SAVINGS       TOTAL SAVINGS                                      (BIL $)
  SSTAX         SOCIAL SECURITY TAX REVENUE                        (BIL $)
  TARIFF        TARIFF REVENUE                                     (BIL $)
  YH(hh)        HOUSEHOLD INCOME                                   (BIL $)
  YINST(ins)    INSTITUTIONAL INCOME                               (BIL $)

*## GDP CALCULATIONS
  RGDP          REAL GDP                                           (BIL 82$)
  GDPVA         NOMINAL GDP VALUE ADDED AT MARKET PRICE            (BIL $)
    ;

*################# VARIABLE INITIALIZATION ##############################################
* NOTE THAT EXACT EQUATION ANALOGS ARE USED FOR INITIALIZATION:
  EXR.L        =  EXR0 ;
  P.L(i)       =  P0(i) ;
  PD.L(i)      =  PD0(i) ;
  PE.L(i)      =  PE0(i) ;
  PM.L(i)      =  PM0(i) ;
  PX.L(i)      =  PX0(i)  ;

  E.L(i)       =  E0(i) ;
  M.L(i)       =  M0(i) ;
  XD.L(i)      =  XD0(i) ;
  DST.L(i)     =  DST0(i) ;
  GD.L(i)      =  GD0(i) ;
  XF.L(I)      =  XF0(I) ;
```

```
INT.L(i)         =  SUM(J,IO(I,J)*XD.L(J)) ;
XS.L(i)          =  XD.L(i)-XF.L(I) ;
XXD.L(i)         =  (PX.L(I)*XS.L(I)-PE.L(I)*E.L(I))/PD.L(I) ;
X.L(i)           =  (PD.L(I)*XXD.L(I) + PM.L(I)*M.L(I))/P.L(I) ;

XPR.L(I)             =  XP0(I)/XD0(I) ;
PCON(i)$XPR.L(i)     =  XPR.L(i)/((1/(1+exp(-1.0)))-.50) ;
XPR.L(i)             =  pcon(i)*((1/(1+exp(-1.0)))-.50) ;
FS0(i,"land")        =  EMPL0(I,"LAND") + ARP0(i) ;
LP.L(I)              =  (XPR.L(I)*EMPL0(I,"LAND")) + ARP0(i) ;
ARP.L(I)$LP.L(I)     =  ARP0(i)/LP.L(i) ;
FS.L(I,"LAND")       =  FS0(I,"LAND") - (ARP.L(i)*LP.L(I)) ;

TP.L(I)          =  TP0(I)  ;
PGAP.L(I)        =  TP.L(I) - PX.L(I) ;
PL.L(I)          =  PL0(I)  ;
XF.L(iF)         =  XF0(iF) ;
XL.L(iL)         =  XL0(iL) ;
XP.L(iP)         =  XP0(iP) ;
LFB.L(iF)        =  XF.L(IF)*(PL.L(IF)-PX.L(iF)) ;
LSB.L(iL)        =  XL.L(IL)*LSBR(iL) ;
DEFPAY.L(iT)     =  XP.L(iT)*(TP.L(IT)-PL.L(IT)) ;
PIE.L(iP)        =  (LFB.L(IP)+DEFPAY.L(IP)-ASSMNT(IP))/XD.L(IP) ;
CCCE.L           =  SUM(IF,PX.L(IF)*XF.L(IF)) ;
EEP.L(i)         =  EEPN0(i) ;
TEE.L(i)         =  0.0 ;
TEE.L(iep)       =  EEP.L(iep)/((PE.L(iep)*E.L(iep))-EEP.L(iep)) ;
FPE.L            =  CCCE.L + DIRPAY + FORTOT +
                 SUM(I,LFB.L(I)+DEFPAY.L(I)+LSB.L(I)+EEP.L(I)-ASSMNT(I)) ;
TMQ.L(i)         =  TMQ0(i)  ;

PK.L(i)          =  SUM(J,P.L(J)*IMAT(J,i)) ;
PVA.L(i)         =  PX.L(I)*(1-ITAX(I))-SUM(J,P.L(J)*IO(J,I))+PIE.L(I) ;

TM.L(I)          =  TM0(I) ;
PWM.L(i)         =  PM.L(I)/(EXR.L*(1+TM.L(I)+TMQ.L(I))) ;
PWE.L(i)         =  PE.L(I)/(EXR.L*(1+TEE.L(I))) ;
PREMIUM.L(i)     =  TMQ.L(i)*PWM.L(I)*M.L(I)*EXR.L ;
TARIFF.L         =  SUM(i,TM.L(i)*PWM.L(i)*M.L(i))*EXR.L ;

WF.L(f)          =  WF0(f) ;
WFDIST.L(i,f)    =  WFDIST0(i,f) ;
FD.L(i,f)        =  EMPL0(I,F) ;
FS.L(I,FM)       =  EMPL0(I,FM) ;

FYS.L(i,f)       =  WF.L(F)*WFDIST.L(i,f)*FD.L(i,F) ;
FY.L(f)          =  SUM(i,FYS.L(i,f)) ;
GENT.L           =  GENT0 ;
DEPRECIA.L       =  SUM(i,DEP0(i)) ;
SSTAX.L          =  SSTR*FY.L("LABOR") ;
FRETAX.L         =  FRETR*(FY.L("LAND")+DIRPAY+FORTOT) ;

ENTTAX.L         =  ETR*(SUM(I,FYS.L(I,"CAPITAL")
                       + PREMIUM.L(I) + LSB.L(I)
                       - DEPR(I)*PK.L(I)*FD.L(I,"CAPITAL"))
                       + (EROW-MROW)*EXR.L + GENT.L ) ;
```

```
ENTSAV.L          = ESR*(SUM(I,FYS.L(I,"CAPITAL")
                        + PREMIUM.L(I) + LSB.L(I)
                        - DEPR(I)*PK.L(I)*FD.L(I,"CAPITAL"))
                        + (EROW-MROW)*EXR.L + GENT.L - ENTTAX.L) ;
  HHT.L             = HHT0 ;
  YINST.L("farml")  =  (1-SSTR)*SUM(iag,FYS.L(iag,"labor")) ;
  YINST.L("farmk")  =  (1-ESR)*(1-ETR)
                       *( SUM(iag,FYS.l(iag,"capital")
                       + PREMIUM.L(iag) + LSB.L(iag)
                       - DEPR(iag)*PK.L(iag)*FD.L(iag,"CAPITAL"))) ;
  YINST.L("farmt")  =  (1-FRETR)*(FY.L("land")+DIRPAY+FORTOT) ;
  YINST.L("salary") =  (1-SSTR)*SUM(inag,FYS.L(inag,"labor")) ;
  YINST.L("ent")    =  (1-ESR)*(1-ETR)
                       *( SUM(inag,FYS.l(inag,"capital")
                       + PREMIUM.L(inag) + LSB.L(inag)
                       - DEPR(inag)*PK.L(inag)*FD.L(inag,"CAPITAL"))
                       + GENT.L + (EROW-MROW)*EXR.L) ;
  YINST.L("foreign")  =  REMIT*EXR.L ;
  YINST.L("welfare")  =  HHT.L ;
  YH.L(hh)            =  SUM(INS,SINTYH(HH,INS)*YINST.L(INS)) ;

  MPS.L(hh)     =  HHPAR(hh,"MPS")*HHSAV0 ;
  MPS.L(hh)     =  MPS.L(hh)/(YH.L(hh)*(1-HTAX(hh))) ;
  HHSAV.L       =  SUM(HH,MPS.L(HH)*(1-HTAX(HH))*YH.L(HH)) ;

  HHTAX.L       =  SUM(HH,HTAX(HH)*YH.L(HH)) ;
  FSAV.L        =  FSAV0 ;
  GDTOTN.L      =  SUM(i,GD.L(i)*P.L(i)) ;

  CLES.L(I,HH)    =  CDHH(I,HH) ;
  CLES.L(I,HH)    =  CLES.L(I,HH)/SUM(J,CLES.L(J,HH)) ;
* CLES.L(I,HH)    =  (CDHH(I,HH)*P.L(I))
*                    /((1-MPS.L(HH))*(1-HTAX(HH))*YH.L(HH)) ;
* CLES.L(I,HH)    =  CLES.L(I,HH)/SUM(J,CLES.L(J,HH)) ;
  CD.L(I)         =  SUM(HH,CLES.L(I,HH)*(1-MPS.L(HH))*(1-HTAX(HH))*YH.L(HH))
                     /P.L(I);

  INDTAX.L        =  SUM(i,ITAX(i)*PX.L(i)*XD.L(i)) ;
  GR.L            =  INDTAX.L+FRETAX.L+SSTAX.L+ENTTAX.L+TARIFF.L+HHTAX.L ;
  GOVSAV.L        =  GR.L-GDTOTN.L-GENT.L-HHT.L-FPE.L+FBOR*EXR.L ;
  SAVINGS.L       =  HHSAV.L+ENTSAV.L+GOVSAV.L+DEPRECIA.L+FSAV.L*EXR.L ;

  INVEST.L        =  SAVINGS.L ;
* INVEST.L        =  invest0 ;
  FXDINV.L        =  INVEST.L - SUM(i, P.L(i)*DST.L(i)) ;
  DK.L(i)         =  (KISH(i)*FXDINV.L)/PK.L(i) ;
  ID.L(i)         =  SUM(j, IMAT(i,j)*DK.L(j)) ;

  GDPVA.L         =  SUM(i,(PVA.L(i)-PIE.L(i))*XD.L(i)+PREMIUM.L(I))
                      + INDTAX.L + TARIFF.L ;
  RGDP.L          =  SUM(I, CD.L(i)+DST.L(i)+ID.L(i)+GD.L(i)+XF.L(i))
                      + SUM(IE,E.L(IE)) - SUM(IM, (1.0-TMREAL(IM))*M.L(IM)) ;

  PINDEX.L  = GDPVA.L/RGDP.L ;

*############# SAM BALANCE DATA CONSISTENCY CHECK ######################################
```

```
SAM("COMMDTY","ACTIVITY")        = SUM(i,P.L(i)*INT.L(i)) ;
SAM("COMMDTY","HHOLDS")          = SUM(i,P.L(i)*CD.L(i)) ;
SAM("COMMDTY","KACCT")           = SUM(i,P.L(i)*(DST.L(i)+ID.L(i))) ;
SAM("COMMDTY","GOVT")            = SUM(i,P.L(i)*GD.L(i)) ;
SAM("COMMDTY","CCC")             = CCCE.L ;
SAM("ACTIVITY","CCC")            = SUM(i,LFB.L(i)+DEFPAY.L(i)+EEP.L(i));
SAM("ACTIVITY","WORLD")          = SUM(i,EXR.L*PWE.L(i)*E.L(i)) ;
SAM("ACTIVITY","COMMDTY")        = SUM(i,PD.L(i)*XXD.L(i)) + CCCE.L;
SAM("FACTORS","ACTIVITY")        = SUM(i, PVA.L(i)*XD.L(i)) ;
SAM("INST","COMMDTY")            = SUM(i,PREMIUM.L(i)) ;
SAM("INST","FACTORS")            = SUM((i,f),ALPHA(i,f)*PVA.L(i)*XD.L(i)) ;
SAM("INST","GOVT")               = GENT.L + HHT.L ;
SAM("INST","CCC")                =DIRPAY + FORTOT + SUM(i,LSB.L(i)) ;
SAM("INST","WORLD")              = (EROW-MROW + REMIT)*EXR.L ;
SAM("HHOLDS","INST")             = SUM(hh,YH.L(hh)) ;
SAM("GOVT","COMMDTY")            = TARIFF.L ;
SAM("GOVT","ACTIVITY")           = SUM(i,ITAX(i)*XD.L(i)*PX.L(i)) ;
SAM("GOVT","INST")               = SSTAX.L + ENTTAX.L + FRETAX.L ;
SAM("GOVT","HHOLDS")             = HHTAX.L ;
SAM("CCC","ACTIVITY")            = SUM(i,ASSMNT(i)) ;
SAM("CCC","GOVT")                = FPE.L ;
SAM("KACCT","INST")              = ENTSAV.L + DEPRECIA.L ;
SAM("KACCT","HHOLDS")            = HHSAV.L ;
SAM("KACCT","GOVT")              = GOVSAV.L ;
SAM("KACCT","WORLD")             = FSAV.L * EXR.L ;
SAM("WORLD","COMMDTY")           = SUM(I,PWM.L(i)*M.L(i)*EXR.L) ;
SAM("WORLD","GOVT")              = -FBOR * EXR.L ;
SAM("TOTALS",col)                = SUM(row,SAM(row,col)) ;
SAM(row,"TOTALS")                = SUM(col,SAM(row,col)) ;

OPTIONS DECIMALS=6 ;
PARAMETER CHECK ;
CHECK = SUM(row,(ABS(SAM(row,"TOTALS") - SAM("TOTALS",row)))) ;
ABORT $(CHECK GT 0.000005)
"SAM ROW AND COLUMN SUMS NOT EQUAL", CHECK, SAM ;
DISPLAY "INITIALIZATION SAM BALANCES ($1.00 PRECISION)",CHECK,SAM ;
DISPLAY "INITIAL VALUES", RGDP.L, GDPVA.L, FXDINV.L, PINDEX.L ;

*######################### THE CGE MODEL ##################################################

*#################### EQUATION DECLARATION ################################################

EQUATIONS

*## PRICES
    PMDEF(i)          DOMESTIC IMPORT PRICES OR IMPORT SUPPLY CURVE
    PEDEF(i)          DOMESTIC EXPORT PRICES OR EXPORT DEMAND CURVE
    ABSORPTION(i)     VALUE OF TOTAL SALES IN DOMESTIC MARKET
    SALES(i)          VALUE OF OUTPUT
    ACTP(i)           ACTIVITY PRICE
    PKDEF(i)          CAPITAL GOOD PRICE
    PINDEXDEF         GENERAL PRICE LEVEL
*## FARM PROGRAMS
    CCCEQ             CCC COST OF FORFEITED CROPS
    DPAYEQ(i)         DEFICIENCY PAYMENTS COST
    PREMDEF(i)        QUOTA PREMIA RECEIVED DOMESTICALLY
```

EEPDEF(i)	EXPORT SUBSIDIES RECEIVED DOMESTICALLY
FPEQ	TOTAL FARM PROGRAM EXPENDITURES
LFBEQ(i)	LOAN FORFEIT BENEFIT
LSBEQ(i)	LOAN SUBSIDY BENEFIT
LSEQ(I)	TOTAL LAND SUPPLY CONSTRAINT
LPEQ(I)	LAND IN PROGRAM CROPS
PIEQ(i)	PRODUCER INCENTIVE EQUIVALENTS PER UNIT OUTPUT
PGAPEQ(I)	SUBSIDY RATE PRICE GAP
XFEQ(i)	OUTPUT FORFEITED UNDER LOAN PROGRAM
XPEQ(i)	OUTPUT UNDER PROGRAM
XPREQ(I)	PROGRAM OUTPUT AND LAND USE RATE
XSUPPLY(i)	DOMESTIC SUPPLY EXCLUDING CCC STOCKS
*## QUANTITIES	
ACTIVITY(i)	PRODUCTION FUNCTION
PROFITMAX(i,f)	OPTIMAL INPUT DEMANDS FOC FOR PROFIT MAX
COSTMIN(i)	COST MINIMIZATION FOR COMPOSITE GOOD DEMAND
CES1(i)	CES AGGREGATION OF IMPORTS AND DOMESTIC VERSIONS
CES2(i)	COMPOSITE GOOD IN NONTRADED SECTORS
INTEQ(i)	INTERMEDIATE GOOD DEMAND
CET(i)	CET TRANSFORMATION FOR EXPORTS VS DOMESTIC SALES
CET2(i)	DOMESTIC SALES FOR NONTRADED SECTORS
ESUPPLY(i)	EXPORT SUPPLY
EDEMAND(i)	ROW DEMAND FOR US EXPORTS IN LARGE MARKETS
*## NOMINAL TRANSACTIONS	
FYEQ(f)	FACTOR INCOME
FYSEQ(i,f)	FACTOR INCOME BY SECTOR
FLYEQ	FARM LABOR INSTITUTIONAL NET INCOME
FKYEQ	FARM CAPITAL INSTITUTIONAL NET INCOME
FTYEQ	FARM LAND INSTITUTIONAL NET INCOME
SALEQ	WAGE AND SALARY INSTITUTIONAL NET INCOME
INDTAXDEF	INDIRECT TAXES ON DOMESTIC PRODUCTION
DEPRECIAEQ	TOTAL DEPRECIATION EXPENDITURE
FRETAXDEF	FARM REAL ESTATE TAXES
TAXSS	SOCIAL SECURITY TAX
ETAX	ENTERPRISE TAX
ESAVE	ENTERPRISE SAVING
ENTYEQ	NON FARM ENTERPRISE NET INCOME
FORYEQ	NET INCOME FROM ABROAD
WYEQ	GOVT TRANSFER INCOME
HHYEQ(hh)	HOUSEHOLD INCOME
TARIFFDEF	TARIFF REVENUE
HHTAXDEF	TOTAL HOUSEHOLD TAX REVENUES
HHSAVEQ	HOUSEHOLD SAVING
GREQ	GOVERNMENT REVENUE
TOTSAV	TOTAL SAVINGS
CDEQ(i)	PRIVATE CONSUMPTION DEMAND BEHAVIOR
CLESEQ(hh)	CLES MUST SUM TO ONE
* MPSEQ(hh)	MAINTAIN EXPENDITURE EQUALS INCOME BY MPS
GDEQI(i)	GOVT CONSUMPTION EXCL CCC FORFEITS
GBUDGET	GOVERNMENT BUDGET BALANCE
DSTEQ(i)	INVENTORY INVESTMENT
FIXEDINV	INVESTMENT not incl INVENTORY
PRODINV(i)	FIXED INVESTMENT BY DESTINATION
IEQ(i)	FIXED INVESTMENT DEMAND FOR GOOD i
*## MARKET CLEARING	
EQUIL(i)	GOODS MARKET EQUILIBRIUM

```
    FMEQUIL(f)          MOBILE FACTOR MARKET EQUILIBRIUM
    LMKT(f)             LAND MARKET
    CAEQ                BALANCE OF PAYMENTS ON CURRENT ACCOUNT
*   KMKT                LOANABLE FUNDS MARKET EQUILIBRIUM
*## GROSS NATIONAL PRODUCT
    GDPY                TOTAL VALUE ADDED INCLUDING INDTAX
    GDPR                REAL GDP
      ;

*#################### MODEL EQUATIONS ##################################################

*## PRICES ##############
    PMDEF(im)..         PM(im) =E= PWM(im)*EXR*(1+TM(im)+TMQ(im))  ;

    PREMDEF(IQ)..       PREMIUM(IQ) =E= TMQ(IQ)*PWM(IQ)*M(IQ)*EXR ;

    EEPDEF(iep)..       EEP(iep) =E= TEE(iep)*PWE(iep)*E(iep)*EXR ;

    PEDEF(ie)..         PE(ie) =E= PWE(ie)*(1 + TEE(ie))*EXR ;

    ABSORPTION(i)..     P(i)*X(i) =E= PD(i)*XXD(i) + (PM(i)*M(i))$im(i) ;

    SALES(i)..          PX(i)*XS(i) =E= PD(i)*XXD(i) + (PE(i)*E(i))$ie(i) ;

    ACTP(i)..           PVA(i) =E= PX(i)*(1-ITAX(i))
                           - SUM(j, IO(j,i)*P(j))
                           + PIE(i) ;

    PKDEF(i)..          PK(i) =E= SUM(j, P(j)*IMAT(j,i) );

*## DOMESTIC FARM PROGRAMS #############

    XFEQ(IF)..          XF(IF) =E= XF00(IF)+XF0(IF)*(PL(IF)/PX(IF))**FELAS(IF);

    PGAPEQ(IT)..        PGAP(IT) =E= TP(IT) - PX(IT)  ;

    XPREQ(IT)..         XPR(IT) =E= PCON(IT) *
                           (1/(1+EXP(-(PGAP(IT)/PGAP0(IT))))-.5);

    LPEQ(I)..           LP(I) =E= (XPR(I)*FS(I,"LAND"))/(1-ARP(I)) ;

    LSEQ(I)..           FS(I,"LAND") =E= FS0(I,"LAND") - ARP(I)*LP(I) ;

    LFBEQ(IF)..         LFB(IF) =E= XF(IF)*(PL(IF)-PX(IF)) ;

    LSBEQ(IL)..         LSB(IL) =E= XL(IL)*LSBR(IL) ;

    XPEQ(IT)..          XP(IT) =E= XPR(IT)*XD(IT) ;

    DPAYEQ(it)..        DEFPAY(it) =E= XP(it)*(TP(it)-PL(it)) ;

    PIEQ(IP)..          PIE(IP) =E= (LFB(IP)+DEFPAY(IP)-ASSMNT(IP))/XD(IP) ;

    CCCEQ..             CCCE =E= SUM(if,PX(if)*XF(if)) ;
```

```
FPEQ..              FPE =E= CCCE + DIRPAY + FORTOT +
                       SUM(I,LFB(I)+DEFPAY(I)+LSB(I)+EEP(I)-ASSMNT(I)) ;

SUPPLY(i)..         XS(i) =E= XD(i) - XF(i) ;

*## QUANTITY EQUATIONS ###################

ACTIVITY(i)..       XD(i)=E=AD(i)*PROD(f$EMPL0(i,f),FD(i,f)**ALPHA(i,f));

PROFITMAX(i,f)$EMPL0(i,f)..  WF(F)*WFDIST(i,f)*FD(i,f) =E= XD(i)
                                               *PVA(i)*ALPHA(i,f) ;

COSTMIN(IM)..       M(IM) =E= XXD(IM)*((PD(IM)/PM(IM))*DELTA(IM)
                              /(1-DELTA(im)) )**(1/(1 + RHOC(im))) ;

CES1(IM)..          P(IM)*AC(IM) =E= ((DELTA(IM)**SIGMA(IM))
                    *(PM(IM)**(1-SIGMA(IM))) + ((1-DELTA(IM))**SIGMA(IM))
                    *(PD(IM)**(1-SIGMA(IM))))**(1/(1-SIGMA(IM))) ;

CES2(IMN)..         P(IMN) =E= PD(IMN);

CET(ie)..           XS(ie) =E= AT(ie)*( GAMMA(ie)*E(ie)**RHOT(ie) +
                        (1-GAMMA(ie))*XXD(ie)**RHOT(ie))**(1/RHOT(ie)) ;

CET2(ien)..         XS(ien) =E= XXD(ien) ;

ESUPPLY(ie)..       E(ie) =E= XXD(ie)*( PE(ie)/PD(ie)*(1 - GAMMA(ie))
                           /GAMMA(ie))**(1/(RHOT(ie)-1)) ;

EDEMAND(iel)..      E(iel) =E= ECONST(iel)*((PWE(iel)/PWSE(iel))
                             **(-RHOE(iel))) ;

*## NOMINAL FLOWS #################################

FYSEQ(i,f)..        FYS(i,f) =E= WF(f)*WFDIST(i,f)*FD(i,f) ;

FYEQ(f)..           FY(f) =E= SUM(i,FYS(i,f));

INDTAXDEF..         INDTAX =E= SUM(i, ITAX(i)*PX(i)*XD(i) ) ;

FRETAXDEF..         FRETAX =E= FRETR*(FY("land")+DIRPAY+FORTOT) ;

TAXSS..             SSTAX =E= SSTR * FY("labor") ;

DEPRECIAEQ..        DEPRECIA =E= SUM(i,DEPR(i)*PK(i)*FD(i,"capital")) ;

ETAX..              ENTTAX =E= ETR*(FY("capital")
                                  + SUM(I,PREMIUM(I)+LSB(I))
                                  + (EROW-MROW)*EXR + GENT
                                  - DEPRECIA ) ;

ESAVE..             ENTSAV =E= ESR*(FY("capital")
                                  + SUM(I,PREMIUM(I)+LSB(I))
                                  + (EROW-MROW)*EXR + GENT
                                  - DEPRECIA - ENTTAX ) ;
```

```
    FLYEQ..          YINST("farmL") =E= (1-SSTR)*SUM(iag,FYS(iag,"labor")) ;

    FKYEQ..          YINST("farmk") =E= (1-ESR)*(1-ETR)
                                *(SUM(IAG,FYS(IAG,"CAPITAL")
                                + PREMIUM(IAG) + LSB(IAG)
                                - DEPR(IAG)*PK(IAG)*FD(IAG,"CAPITAL"))) ;

    FTYEQ..          YINST("farmt") =E= (1-FRETR)*(FY("land")
                                + FORTOT + DIRPAY) ;

    SALEQ..          YINST("salary") =E= (1-SSTR)*SUM(inag,FYS(inag,"labor"));

    ENTYEQ..         YINST("ent") =E= (1-ESR)*(1-ETR)
                       * (SUM(INAG,FYS(INAG,"CAPITAL")
                       + PREMIUM(INAG) + LSB(INAG)
                       - DEPR(INAG)*PK(INAG)*FD(INAG,"CAPITAL"))
                       + (EROW-MROW)*EXR + GENT) ;

    FORYEQ..         YINST("foreign") =E= REMIT*EXR ;

    WYEQ..           YINST("welfare") =E= HHT ;

    HHYEQ(hh)..      YH(hh) =E= SUM(ins,SINTYH(hh,ins)*YINST(ins)) ;

    HHTAXDEF..       HHTAX =E= SUM(hh, HTAX(hh)*YH(hh) ) ;

    HHSAVEQ..        HHSAV =E= SUM(hh, MPS(hh)*YH(hh)*(1-HTAX(hh))) ;

    TARIFFDEF..      TARIFF =E= SUM(im,TM(im)*M(im)*PWM(im))*EXR ;

    GREQ..           GR =E= ENTTAX+FRETAX+HHTAX+INDTAX+SSTAX+TARIFF ;

    GBUDGET..        GOVSAV =E= GR-GDTOTN-GENT-HHT-FPE+FBOR*EXR ;

    TOTSAV..         SAVINGS =E= DEPRECIA+ENTSAV+HHSAV+GOVSAV+FSAV*EXR ;

    FIXEDINV..       FXDINV =E= INVEST - SUM(i,DST(i)*P(i)) ;

    PRODINV(i)..     PK(i)*DK(i) =E= KISH(i)*FXDINV ;

*## FINAL DEMAND

    INTEQ(i)..       INT(i) =E= SUM(j, IO(i,j)*XD(j) );

    CDEQ(i)..        CD(i)*P(i) =E= SUM(HH,CLES(I,HH)*(1-MPS(HH))*YH(HH)
                               *(1-HTAX(hh)) ) ;
    CLESEQ(hh)..     SUM(i,CLES(i,hh)) =E= 1.0 ;

$ontext
    MPSEQ(hh)..      MPS(hh) =E= 1 - HTAX(hh) -
       (SUM(i,CLES(i,hh)*(1-MPS(hh))*YH(hh)*(1-HTAX(hh)))/YH(hh));
$offtext

    GDEQI(i)..       GD(i)*P(i) =E= GLES(i)*GDTOTN ;

    DSTEQ(i)..       DST(i) =E= DSTR(i)*XD(i) ;
```

```
IEQ(i)..          ID(i) =E= SUM(j, IMAT(i,j)*DK(j)) ;

*## MARKET CLEARING ############################

EQUIL(i)..        X(i) =E= INT(i)+CD(i)+GD(i)+ID(i)+DST(i) ;

FMEQUIL(FM)..     SUM(i, FD(i,fm)) =E= SUM(i, FS(i,fm)) ;

LMKT(FMN)..       SUM(i, FD(i,fmn)) =E= SUM(i, FS(i,fmn)) ;

CAEQ..            SUM(im, PWM(im)*M(im))+MROW =E=
                  SUM(ie, PWE(ie)*E(ie))+EROW+FSAV+REMIT+FBOR ;

* KMKT..          SAVINGS =E= INVEST ;

*## PRODUCT AND PRICE INDEX ####################

GDPY..            GDPVA =E= SUM(i,(PVA(i)-PIE(i))*XD(i)+PREMIUM(I))
                  +INDTAX+TARIFF ;

GDPR..            RGDP =E= SUM(I,CD(i)+DST(i)+ID(i)+GD(i)+XF.L(i))
                  +SUM(ie,E(ie)) - SUM(im,(1.0-TMREAL(im))*M(im)) ;

PINDEXDEF..       PINDEX =E= GDPVA/RGDP ;

*################ BOUNDS TO AVOID UNDF EQUATIONS, ETC ################

FD.LO(i,f)$EMPL0(i,f)  = 0.00001 ;
PD.LO(IM)              = 0.00001 ;
PM.LO(IM)              = 0.00001 ;
E.LO(IE)               = 0.00001 ;
XXD.LO(IE)             = 0.00001 ;
XD.LO(I)               = 0.00001 ;

CD.FX("CONSTRU")       = 0.0 ;
GD.FX("SUGAR")         = 0.0 ;
FD.FX(i,f)$(EMPL0(i,f) EQ 0.0) = 0.0 ;

*################### MODEL CLOSURE ######################

*## TRADE POLICY ###########################
*#quotas
M.FX(IQ)             = M.L(IQ) ;
*#export subsidies
TEE.FX(i)            = TEE.L(i) ;
*#Import tariffs
TM.FX(I)             = TM.L(I) ;
*#neutralize policy in unaffected sectors
TMQ.FX(IQN)          = 0.0 ;
PREMIUM.FX(IQN)      = 0.0 ;
EEP.FX(IEPN)         = 0.0 ;
*## DOMESTIC FARM PROGRAMS ################
*#set instruments
ARP.FX(I)            = ARP.L(I) ;
PL.FX(I)             = PL.L(I) ;
TP.FX(I)             = TP.L(I) ;
```

```
*#participation exogenous or endogenous?
    XL.FX(i)            =  XL.L(i) ;
*   LP.FX(IT)           =  LP.L(IT) ;
*   XPR.FX(i)           =  XPR.L(i) ;
*#neutralize instruments in non-program sectors
    XF.FX(IFN)          =  0.0 ;
    XP.FX(ITN)          =  0.0 ;
    DEFPAY.FX(ITN)      =  0.0 ;
    LP.FX(ITN)          =  0.0 ;
    LFB.FX(IFN)         =  0.0 ;
    LSB.FX(ILN)         =  0.0 ;
    PIE.FX(IPN)         =  0.0 ;

*## FACTOR MOBILITY  ############################

    WFDIST.FX(I,F)      =  WFDIST.L(I,F) ;
    FS.FX(I,FM)         =  FS.L(I,FM) ;
*   WFDIST.FX(I,FM)     =  WFDIST.L(I,FM) ;
*   WF.FX(FMN)          =  WF.L(FMN) ;
*   FD.FX(I,FMN)        =  FD.L(I,FMN) ;

*## INTERNATIONAL FINANCE ######################
*   EXR.FX              =  EXR.L ;
    FSAV.FX             =  FSAV.L ;

*## GOVT BUDGET ################################
    GDTOTN.FX           =  GDTOTN.L ;
    GENT.FX             =  GENT.L ;
    HHT.FX              =  HHT.L ;
*   GOVSAV.FX           =  GOVSAV.L ;

*## HOUSEHOLD VARIABLES #######################
    CLES.FX(i,hh)       =  CLES.L(i,hh) ;
    MPS.FX(hh)          =  MPS.L(hh) ;
*   CD.FX(iag,hh)       =  CD.L(iag,hh) ;
*   CD.FX(ipf,hh)       =  CD.L(ipf,hh) ;

*## NUMERAIRE PRICE INDEX ####################
    PINDEX.FX           =  PINDEX.L ;

*## NONTRADED AND SMALL SECTORS ##############
    PM.FX(IMN)          =  PM.L(IMN) ;
    PE.FX(IEN)          =  PE.L(IEN) ;
    PWE.FX(IES)         =  PWE.L(IES) ;
    PWM.FX(IM)          =  PWM.L(IM) ;
    E.FX(IEN)           =  0.0 ;
    M.FX(IMN)           =  0.0 ;
```

```
*############################ SOLVE STATEMENT ##############################

OPTIONS ITERLIM=1000, LIMROW=0, LIMCOL=0, DOMLIM=30, SOLPRINT=OFF,
    NLP=MINOS5 ;

MODEL FPGE / ALL / ;

SOLVE FPGE MAXIMIZING RGDP USING NLP;

*########################### END OF MODEL ###############################
```

APPENDIX II. FARMDATA GAMS Model for Normalizing and Aggregating Policy Data

```
                              VERSION 11/21/90

     This gams file is designed to aggregate the input data concerning farm programs for
     the 30-sector FPGE models.

     It is written by M.KILKENNY  BITNET: MRK5@psuvm
     Questions?  Call (814) 865-1106.


SETS

Y      CALENDAR YEAR          / 82 * 90 /

I      ALL SECTORS            / DAIRY     MILK
                                poultry, eggs, cattle, hogs, sheep,
                                COTTON,
                                wheat, rice, rye,
                                corn, oats, barley, sorghum,
                                soybeans, peanuts,
                                SUGAR          BEET AND CANE SUGAR
                                tobacco, necag,
                                butter, cheese, drymilk,
                                LVSTK          MEAT POULTRY EGGS
                                FOODGRN        WHEAT RICE RYE
                                FEEDCRP        CORN OATS BARLEY SORGHUM ETC
                                OILCROP        SOYBEANS PEANUTS OILSEEDS
                                OTHCROP        TOBACCO FRUIT VEGES FORESTRY
                                MEATMNF        PROCESEED MEAT
                                DAIRYMN        BUTTER CHEESE DRY MILK
                                GRNMILL        GRAIN MILLING
                                FEEDMNF        PREPARED FEEDS
                                SUGARMN        SUGAR REFINING
                                SOYMILL        SOY OIL PROCESSING
                                MISCFOO        FOOD PROCESSING NEC /

A(i)   AGGREGATES             / DAIRY, COTTON, SUGAR,
                                LVSTK, FOODGRN, FEEDCRP, OILCROP, OTHCROP,
                                MEATMNF, DAIRYMN, GRNMILL, FEEDMNF,
                                SUGARMN, SOYMILL, MISCFOO /

S(i)   SUBSECTORS             / poultry, eggs, cattle, hogs, sheep,
                                wheat, rice, rye,
                                corn, oats, barley, sorghum,
                                soybeans, peanuts,
                                tobacco, necag,
                                butter, cheese, drymilk /

lv(i)  LIVESTOCK SECTORS      / poultry, eggs, cattle, hogs, sheep /
FG(i)  FOOD GRAIN SECTORS     / wheat, rice, rye /
FD(i)  FEED CROP SECTORS      / corn, oats, barley, sorghum /
OS(i)  OILSEEDS SECTORS       / soybeans, peanuts /
OTH(i) OTHER AG               / tobacco, necag /
```

```
DM(i) DAIRY MNFCTRING       / butter, cheese, drymilk /

ALIAS (A,J) ;

*#####################################################################

PARAMETERS

FORTOT(y)          STORAGE PAYMENTS
NIP(y)             NET INTEREST PAID CCC LOANS
CURSUR(y)          CURRENT SURPLUS
DPAYTOT(y)         DIRECT PAYMENTS
DEFPAYTOT(y)       TOTAL DEFICIENCY PAYMENTS
LMFATOT(y)         TOTAL COMMODITY LOANS
SUBLCS(y)          SUBSIDY LESS CURRENT SURPLUS

PX(y,i)            OUTPUT PRICE THAT YEAR
XD(y,i)            DOMESTIC OUTPUT THAT YEAR
ARP(y,i)           REDUCED OR SET ASIDE ACREAGE
ASSMNT(y,i)        FEES LICENSES ETC
CCCN(y,i)          NOMINAL VALUE TOTAL NET CCC STOCKING
DEFPAY(y,i)        DEFICIENCY PAYMENTS
EEPN(y,i)          EXPORT ENHANCEMENT AWARDS
FPL(y,i)           FINDLEY LOAN RATE
LMFA(y,i)          LOANS MADE FACE AMOUNT AT PL
PL(y,i)            LOAN RATE
TP(y,i)            TARGET PRICE
XL(y,i)            QUANTITY UNDER LOAN
XF(y,i)            OUTPUT FORFEITED
XP(y,i)            OUTPUT UNDER DEFICIENCY PAYMENT PROGRAM
XPR(y,i)           XP AS PROPORTION OF XD

* CALCLATED PARAMETERS #########################

SUMSHI(y,i)        SUM SHARE OVER i
SUMSHA(y,a)        SUM SHARE OVER a
CHECK(y,i)
CHECKSUM(y)

VWTFG(y,fg)        VALUE WEIGHT PROGRAM FOOD GRAINS
VWTFD(y,fd)        VALUE WEIGHT PROGRAM FEED GRAINS

CCCE(y)            MKT VALUE OF SUM FORFEITED OUTPUT
DIRPAY(y)          TOTAL DIRECT NON-DISTORTING PAYMENTS
FPE(y)             NET FARM PROGRAM EXPENDITURES
CCCIVA(y)          TOTAL CCC INVENTORY VALUATION ADJUSTMENT
LFB(y,a)           LOAN FORFEIT BENEFIT
LSB(y,a)           LOAN SUBSIDY BENEFIT

*############ PARAMETER ASSIGNMENT ##############################

TABLE EXPEND(*,y)            FARM PROGRAM EXPENDITURES

      82            86
DPAYTOT             11.80000
```

```
NIP                 1.385
CURSUR              5.6
LMFATOT            17.3910
FORTOT              0.342
DEFPAYTOT          12.0560
SUBLCS             17.4
  ;

FORTOT(y)      = EXPEND("FORTOT",y) ;
NIP(y)         = EXPEND("NIP",y) ;
CURSUR(y)      = EXPEND("CURSUR",y) ;
DPAYTOT(y)     = EXPEND("DPAYTOT",y) ;
DEFPAYTOT(y)   = EXPEND("DEFPAYTOT",y) ;
LMFATOT(y)     = EXPEND("LMFATOT",y) ;
SUBLCS(y)      = EXPEND("SUBLCS",y) ;

TABLE SECTRES(*,y,i)   SECTORAL QUANTITIES AND PRICES
* XD for subsectors here is nominal value of output at market prices
* XD for aggregates is real value of output (1982 prices)

                  DAIRY         LVSTK       MEATMNF

PX.82          1.000000      1.000000      1.000000
PX.86        0.92689207    0.98120407    0.99182006
XD.86       20.34018292   65.87776232   66.68229137

+                 SUGAR       OTHCROP        COTTON

PX.82        1.00000000    1.00000000     59.100000
PX.86        1.01778104    0.97124103     51.500000
XD.86        1.85772549   29.09449768    3.14160509

+               GRNMILL       FEEDMNF       SUGARMN       SOYMILL       MISCFOO

PX.82          1.000000      1.000000      1.000000      1.000000      1.000000
PX.86        0.94200810    0.93701104    1.17558603    0.93425602      1.127800
XD.86       17.09190760   14.28796769   14.31508890   15.32077099    116.126934

+               DAIRYMN        BUTTER        CHEESE       DRYMILK

PX.82          1.000000
PX.86        1.00076705
XD.86       37.26637127

+               POULTRY          EGGS        CATTLE          HOGS         SHEEP

PX.82
PX.86
XD.86             8.860         3.510         20.90           9.6          .444

+               FOODGRN         WHEAT          RICE           RYE

PX.82          1.000000          3.55          8.11
PX.86        0.78168633          2.42          3.75
XD.86        8.51978722         5.044         0.528         0.029

```

```
+           FEEDCRP        CORN         OATS       BARLEY     SORGHUM

PX.82      1.000000        2.68         1.49         2.22        2.52
PX.86    0.82868908        1.49         1.21         1.56        1.36
XD.86   52.28127503      12.541        0.471        0.994       1.316

+           OILCROP    SOYBEANS      PEANUTS      TOBACCO       NECAG

PX.82      1.000000        5.69         1.76
PX.86    0.87737905        4.65         1.53
XD.86   13.54006189       9.326        1.074        1.778
        ;

PX(y,i)                =  SECTRES("PX",y,i) ;
PX(y,i)$PX("82",i)     =  SECTRES("PX",y,i)/PX("82",i) ;
XD(y,i)                =  SECTRES("XD",y,i) ;

*USE XD IN ITS NOMINAL FORM TO FIND VALUE WEIGHTS:
VWTFG(y,fg)$XD(y,"foodgrn") = XD(y,fg)
                       /(XD(y,"foodgrn")*PX(y,"foodgrn")) ;
VWTFD(y,fd)$XD(y,"feedcrp") = XD(y,fd)
                       /(XD(y,"feedcrp")*PX(y,"feedcrp")) ;

* DISPLAY VWTFG, VWTFD ;

* RETURN PX '82 to IT'S NOMINAL FORM FOR further NORMALIZATIONS:
PX("82",i)             =  SECTRES("PX","82",i) ;

* CONVERT DATA ON subsector XD TO REAL $82 FORM:
* (aggregate sector XD already in that form from model)
XD(y,s)$PX(y,s)        =  PX("82",s)*XD(y,s)/SECTRES("PX",y,s) ;

TABLE FARMDAT(*,y,i)   FARM PROGRAM DATA
* XF data is read in as nominal value at current market prices

                    COTTON       SUGAR      BUTTER      CHEESE       DAIRY
ASSMNT.86                                                          .28742
PL.86                55.00
FPL.86               44.00
TP.86                81.00
ARP.86               3.3000
DEFPAY.86            1.042       0.0
LMFA.86              1.9578      0.9672
XF.86                0.122                   2.0360
CCCN.86              0.125       0.0        -0.043      -0.081       -.270
XL.86
EEPN.86

+                  POULTRY        EGGS      CATTLE     GRNMILL     SOYMILL
EEPN.86            0.03197       0.005      0.0162      0.0585     0.00099

+                    WHEAT        RICE         RYE     FOODGRN
PL.86                  3.0        7.20        1.09
FPL.86                2.40        3.82
TP.86                 4.38       11.90
ARP.86               19.80        1.30
```

```
DEFPAY.86           3.550          0.545         0.0
EEPN.86             0.127          0.0015        0.0
XL.86               0.554614       0.130276      0.005417
LMFA.86             1.5703         0.7663        0.0076
XF.86               0.7380         0.1990        0.006
CCCN.86             0.445          0.093         0.0

+                   CORN           OATS       BARLEY      SORGHUM      FEEDCRP
PL.86                 2.40         1.24         1.95         2.280
FPL.86                1.92         0.99         1.56         1.82          0
TP.86                 3.03         1.60         2.60         2.88          0
ARP.86               13.600        0.7          1.800       15.30          0
DEFPAY.86             6.225         .0324       0.3444       0.566         0
EEPN.86               0                                                    0.0284
XL.86                 3.909         .00838      0.16776      0.0130        0
LMFA.86               0                                                    8.8893
XF.86                 5.164         .0050       0.1570       0.4400        0
CCCN.86               4.829                     0.126        0.401         0

+                SOYBEANS       PEANUTS      TOBACCO         NECAG
PL.86             4.77
ARP.86
EEPN.86                                         0.0
XL.86             0.34857
LMFA.86           2.5763         0.2144         0.3598          0.0815
XF.86             0.6430                        0.0
CCCN.86           0.542                         0.0             0.121
    ;

ARP(y,i)                    = FARMDAT("ARP",y,i) ;
ASSMNT(y,i)                 = FARMDAT("ASSMNT",y,i) ;
CCCN(y,i)                   = FARMDAT("CCCN",y,i) ;
DEFPAY(y,i)                 = FARMDAT("DEFPAY",y,i) ;
EEPN(y,i)                   = FARMDAT("EEPN",y,i) ;
LMFA(y,i)                   = FARMDAT("LMFA",y,i) ;
FPL(y,i)                    = FARMDAT("FPL",y,i) ;
PL(y,i)                     = FARMDAT("PL",y,i) ;
TP(y,i)                     = FARMDAT("TP",y,i) ;
XF(y,i)                     = FARMDAT("XF",y,i) ;
XL(y,i)                     = FARMDAT("XL",y,i) ;

*########################################################################

* EQUATE missing PL,TP  to  PX
PL(y,i)$(PL(y,i) EQ 0)      = PX(y,i) ;
FPL(y,i)$(FPL(y,i) EQ 0)    = PX(y,i) ;
TP(y,i)$(TP(y,i) EQ 0)      = PL(y,i) ;

* NORMALIZE ALL POLICY PRICES WRT PX 1982
FPL(y,i)$PX("82",i)         = FPL(y,i)/PX("82",i) ;
PL(y,i)$PX("82",i)          = PL(y,i)/PX("82",i) ;
TP(y,i)$PX("82",i)          = TP(y,i)/PX("82",i) ;

*DISPLAY "normalized but not calibrated:", FPL,PL,TP;

* CALCULATE DEFICIENCY PROGRAM PARTICIPATION RATE ##############
```

```
* AS ACTUAL:POTENTIAL (100% PARTICIPATION) DEFICIENCY PAYMENTS

* aggregate subsector nominal payments data
DEFPAY(y,"lvstk")            = SUM(lv,DEFPAY(y,lv)) ;
DEFPAY(y,"foodgrn")          = SUM(fg,DEFPAY(y,fg)) ;
DEFPAY(y,"feedcrp")          = SUM(fd,DEFPAY(y,fd)) ;
DEFPAY(y,"oilcrop")          = SUM(os,DEFPAY(y,os)) ;
DEFPAY(y,"othcrop")          = SUM(oth,DEFPAY(y,oth)) ;
DEFPAY(y,"dairymn")          = SUM(dm,DEFPAY(y,dm)) ;

FPL(y,"foodgrn")             = SUM(fg,VWTFG(y,fg)*FPL(y,fg)) ;
TP(y,"foodgrn")              = SUM(fg,VWTFG(y,fg)*TP(y,fg)) ;

FPL(y,"feedcrp")             = SUM(fd,VWTFD(y,fd)*FPL(y,fd)) ;
TP(y,"feedcrp")              = SUM(fd,VWTFD(y,fd)*TP(y,fd)) ;

XPR(y,"cotton")$XD(y,"cotton")       =DEFPAY(y,"cotton")
                             /((TP(y,"cotton")-PL(y,"cotton"))*XD(y,"cotton")) ;

XPR(y,"foodgrn")$XD(y,"foodgrn")     =DEFPAY(y,"foodgrn")
                             /SUM(fg,((TP(y,fg)-FPL(y,fg))*XD(y,fg))) ;

XPR(y,"feedcrp")$XD(y,"feedcrp")     =DEFPAY(y,"feedcrp")
                             /SUM(fd,((TP(y,fd)-FPL(y,fd))*XD(y,fd))) ;

XP(y,a) = XPR(y,a)*XD(y,a) ;

*################# AGGREGATE SUBSECTOR DATA #######################

ARP(y,"foodgrn")             = SUM(fg,ARP(y,fg)) ;
ARP(y,"feedcrp")             = SUM(fd,ARP(y,fd)) ;
ARP(y,"oilcrop")             = SUM(os,ARP(y,os)) ;
ARP(y,"othcrop")             = SUM(oth,ARP(y,oth)) ;

CCCN(y,"lvstk")              = SUM(lv,CCCN(y,lv)) ;
CCCN(y,"foodgrn")            = SUM(fg,CCCN(y,fg)) ;
CCCN(y,"feedcrp")            = SUM(fd,CCCN(y,fd)) ;
CCCN(y,"oilcrop")            = SUM(os,CCCN(y,os)) ;
CCCN(y,"othcrop")            = SUM(oth,CCCN(y,oth)) ;
CCCN(y,"dairymn")            = SUM(dm,CCCN(y,dm)) ;

EEPN(y,"lvstk")              = SUM(lv,EEPN(y,lv)) ;
EEPN(y,"foodgrn")            = SUM(fg,EEPN(y,fg)) ;
* EEPN(y,"feedcrp")          = SUM(fd,EEPN(y,fd)) ;
EEPN(y,"oilcrop")            = SUM(os,EEPN(y,os)) ;
EEPN(y,"othcrop")            = SUM(oth,EEPN(y,oth)) ;
EEPN(y,"dairymn")            = SUM(dm,EEPN(y,dm)) ;

LMFA(y,"lvstk")              = SUM(lv,LMFA(y,lv)) ;
LMFA(y,"foodgrn")            = SUM(fg,LMFA(y,fg)) ;
* LMFA(y,"feedcrp")          = SUM(fd,LMFA(y,fd)) ;
LMFA(y,"oilcrop")            = SUM(os,LMFA(y,os)) ;
LMFA(y,"othcrop")            = SUM(oth,LMFA(y,oth)) ;
LMFA(y,"dairymn")            = SUM(dm,LMFA(y,dm)) ;

XF(y,"cotton")$PX(y,"cotton")        = XF(y,"cotton")/PX(y,"cotton") ;
```

```
XF(y,"lvstk")$PX(y,"lvstk")           = SUM(lv,XF(y,lv))/PX(y,"lvstk") ;
XF(y,"foodgrn")$PX(y,"foodgrn")       = SUM(fg,XF(y,fg))/PX(y,"foodgrn") ;
XF(y,"feedcrp")$PX(y,"feedcrp")       = SUM(fd,XF(y,fd))/PX(y,"feedcrp") ;
XF(y,"oilcrop")$PX(y,"OILCROP")       = SUM(os,XF(y,os))/PX(y,"OILCROP") ;
XF(y,"othcrop")$PX(y,"othcrop")       = SUM(oth,XF(y,oth))/PX(y,"othcrop");
XF(y,"dairymn")$PX(y,"dairymn")       = SUM(dm,XF(y,dm))/PX(y,"dairymn");

* CALCULATE real ('82 price) LOAN COLLATERAL
*       IF XL MISSING -- USE LMFA OR XF DATA:
XL(y,i) = XL(y,i)*PX("82",i) ;
XL(y,i)$(FPL(y,i) GT 0.0 AND XL(y,i) EQ 0.0) = LMFA(y,i)/FPL(y,i) ;
XL(y,i)$(XL(y,i) EQ 0.0) = XF(y,i) ;

*################### CALCULATED PARAMETERS ########################

* nominal stocking expenditure at market prices:
CCCE(y)                       = SUM(a,PX(y,a)*XF(y,a)) ;

* forcing reconciliation of sum and total deficiency payments:
SUMSHA(y,a)$DEFPAY(y,a)    = DEFPAY(y,a)/SUM(j,DEFPAY(y,j)) ;
DEFPAY(y,a)                = SUMSHA(y,a)*DEFPAYTOT(y) ;
SUMSHA(y,a)                = 0.0 ;

* identify portion of total direct that are "non-distorting":
DIRPAY(y)            = SUBLCS(y)+SUM(i,ASSMNT(y,i))-DEFPAYTOT(y)-CURSUR(y) ;

* PL calibrated w.r.t. LMFA and XL for normalized transaction PL:
PL(y,a)$XL(y,a)      = LMFA(y,a)/XL(y,a) ;

* reconcile forfeit benefits with inventory valuation adjustments:
CCCIVA(y)            = CURSUR(y) - SUM(a,EEPN(y,a)) - NIP(y) - FORTOT(y) ;
LFB(y,a)             = (PL(y,a) - PX(y,a))*XF(y,a) ;
SUMSHA(y,a)$LFB(y,a)      = LFB(y,a)/SUM(j,LFB(y,j)) ;
LFB(y,a)             = SUMSHA(y,a)*CCCIVA(y)  ;
SUMSHA(y,a)          = 0.0 ;

* reconcile interest subsidies on loans with net interest paid:
SUMSHA(y,a)$LMFA(y,a)   = LMFA(y,a)/SUM(j,LMFA(y,j)) ;
LSB(y,a)             = SUMSHA(y,a)*NIP(y) ;

* define the loan rate WRT PX, CCCIVA, and forfeit benefits:
PL(y,a)$XF(y,a)      = PX(y,a) + LFB(y,a)/XF(y,a) ;

* normalize XL w.r.t calibrated and normalized PL, and data on LMFA:
XL(y,a)$PL(y,a)      = LMFA(y,a)/PL(y,a) ;

* define Target price wrt PL, DEFPAY, and participation rate:
TP(y,a)$XP(y,a)      = PL(y,a) + (DEFPAY(y,a)/XP(y,a))  ;
TP(y,a)$(TP(y,a) LE  PL(y,a))  = PL(y,a) ;

*##################################################################
* find total program expenditures:
FPE(y)               = CCCE(y)+DIRPAY(y)+DEFPAYTOT(y)+FORTOT(y)
                         + SUM(a,EEPN(y,a)+LFB(y,a)+LSB(y,a)-ASSMNT(Y,A)) ;
```

```
446  SUBLCS(y)           =  DIRPAY(y) + DEFPAYTOT(y) + FORTOT(y)
447                          + SUM(a,EEPN(y,a)+LFB(y,a)+LSB(y,a)-ASSMNT(y,a)) ;
448
449  CURSUR(y)           =  FORTOT(y) + SUM(a,EEPN(y,a)+LFB(y,a)+LSB(y,a)) ;
450
451  LMFATOT(y)          =  SUM(a,PL(y,a)*XL(y,a)) ;
452
453  *################## DISPLAY ########################################
454  PX(y,i)$PX("82",i)  =  SECTRES("PX",y,i)/PX("82",i) ;
455
456  OPTION DECIMALS=3 ;
457  DISPLAY CCCIVA,DEFPAYTOT,CCCE,DIRPAY,SUBLCS,CURSUR,NIP,LMFATOT,FPE ;
458
459  SET D /  ARP, ASSMNT, DEFPAY, EEPN, LMFA,
460           XF, XL, XP, PX, PL, TP, LFB, LSB, XPR /;
461
462  PARAMETER PROGRAM(d,y,a)    FARM PROGRAMS CGE MODEL INPUT DATA ;
463
464  PROGRAM("ARP","86",a)          =  ARP("86",a) ;
465  PROGRAM("ASSMNT","86",a)       =  ASSMNT("86",a) ;
466  PROGRAM("EEPN","86",a)         =  EEPN("86",a) ;
467  PROGRAM("DEFPAY","86",a)       =  DEFPAY("86",a) ;
468  PROGRAM("LMFA","86",a)         =  LMFA("86",a) ;
469  PROGRAM("XF","86",a)           =  XF("86",a) ;
470  PROGRAM("XL","86",a)           =  XL("86",a) ;
471  PROGRAM("XP","86",a)           =  XP("86",a) ;
472
473  PARAMETER POLICY(d,y,a)    ADD'L CALIBRATED AND NOMINAL POLICY INFO ;
474
475  POLICY("PL","86",a)            =  PL("86",a) ;
476  POLICY("PX","86",a)            =  PX("86",a) ;
477  POLICY("TP","86",a)            =  TP("86",a) ;
478  POLICY("LFB","86",a)           =  LFB("86",a) ;
479  POLICY("LSB","86",a)           =  LSB("86",a) ;
480  POLICY("XPR","86",a)           =  XPR("86",a) ;
481
482  OPTION DECIMALS=8;
483  DISPLAY "PROGRAMS, 1986", PROGRAM, POLICY ;
484
485  * END OF PROGRAM AND END OF FILE #####################################
```

```
457   PARAMETER CCCIVA   TOTAL CCC INVENTORY VALUATION ADJUSTMENT    3.603
457   PARAMETER DEFPAYTOT  TOTAL DEFICIENCY PAYMENTS                 12.056
457   PARAMETER CCCE   MKT VALUE OF SUM FORFEITED OUTPUT              9.510
457   PARAMETER DIRPAY  TOTAL DIRECT NON-DISTORTING PAYMENTS          0.031
457   PARAMETER SUBLCS   SUBSIDY LESS CURRENT SURPLUS                17.400
457   PARAMETER CURSUR   CURRENT SURPLUS                              5.600
457   PARAMETER NIP     NET INTEREST PAID CCC LOANS                   1.385
457   PARAMETER LMFATOT   TOTAL COMMODITY LOANS                      17.390
457   PARAMETER FPE     NET FARM PROGRAM EXPENDITURES                26.910
```

---- 483 PARAMETER PROGRAM FARM PROGRAMS CGE MODEL INPUT DATA

		DAIRY	COTTON	SUGAR	LVSTK	FOODGRN
ASSMNT	.86	0.28742000				
ARP	.86		3.30000000			21.10000000
DEFPAY	.86		1.02093102			4.01220012
LMFA	.86		1.95780000	0.96720000		2.34420000
XF	.86		0.14000388			1.20636624
XL	.86		2.07501970	0.95030263		2.56566244
EEPN	.86				0.05317000	0.12850000
XP	.86		2.36854615			6.58748538

	+	FEEDCRP	OILCROP	OTHCROP	DAIRYMN	GRNMILL
ARP	.86	31.40000000				
DEFPAY	.86	7.02286886				
LMFA	.86	8.88930000	2.79070000	0.44130000		
XF	.86	6.95797753	0.73286455		2.03443948	
XL	.86	7.68983714	3.18072331	0.45436713		
EEPN	.86	0.02840000				0.05850000
XP	.86	33.25585651				

	+	SOYMILL
EEPN	.86	0.00099000

---- 483 PARAMETER POLICY ADD'L CALIBRATED AND NOMINAL POLICY INFO

		DAIRY	COTTON	SUGAR	LVSTK	FOODGRN
PX	.86	0.92689207	0.87140440	1.01778104	0.98120407	0.78168633
PL	.86	0.92689207	0.94350912	1.01778104	0.98120407	0.91368216
TP	.86	0.92689207	1.37454611	1.01778104	0.98120407	1.52274615
LFB	.86		0.01009494			0.15923532
LSB	.86		0.15592151	0.07702895		0.18669486
XPR	.86		0.75392867			0.77319834

	+	FEEDCRP	OILCROP	OTHCROP	MEATMNF	DAIRYMN
PX	.86	0.82868908	0.87737905	0.97124103	0.99182006	1.00076705
PL	.86	1.15598027	0.87737905	0.97124103	0.99182006	1.56938805
TP	.86	1.36715717	0.87737905	0.97124103	0.99182006	1.56938805
LFB	.86	2.27728473				1.15682501
LSB	.86	0.70795437	0.22225465	0.03514565		
XPR	.86	0.63609498				

	+	GRNMILL	FEEDMNF	SUGARMN	SOYMILL	MISCFOO
PX	.86	0.94200810	0.93701104	1.17558603	0.93425602	1.12780000
PL	.86	0.94200810	0.93701104	1.17558603	0.93425602	1.12780000
TP	.86	0.94200810	0.93701104	1.17558603	0.93425602	1.12780000

**** FILE SUMMARY FOR USER MRK5
INPUT FARMDATA GAMS A
OUTPUT FARMDATA LISTING A

EXECUTION TIME = 0.460 SECONDS

* U.S. G.P.O.:1991-281-063:40318/ERS

Save by subscribing for up to 3 years!

Situation and Outlook Reports. These reports provide timely analyses and forecasts of all major agricultural commodities and related topics such as finance, farm inputs, land values, and world and regional developments.

	1 year	2 years	3 years
Agricultural Income and Finance (4 per year)	_____ $12	_____ $23	_____ $33
Agricultural Resources (5 per year, each devoted to one topic, including *Inputs, Agricultural Land Values and Markets*, and *Cropland, Water, and Conservation.*)	_____ $12	_____ $23	_____ $33
Aquaculture (2 per year)	_____ $12	_____ $23	_____ $33
Cotton and Wool (4 per year)	_____ $12	_____ $23	_____ $33
Dairy (5 per year)	_____ $12	_____ $23	_____ $33
Feed (4 per year)	_____ $12	_____ $23	_____ $33
Fruit and Tree Nuts (4 per year)	_____ $12	_____ $23	_____ $33
Livestock and Poultry (6 per year)	_____ $17	_____ $33	_____ $48
Livestock and Poultry Update (monthly)	_____ $15	_____ $29	_____ $42
Oil Crops (4 per year)	_____ $12	_____ $23	_____ $33
Outlook for U.S. Agricultural Exports (4 per year)	_____ $12	_____ $23	_____ $33
Rice (3 per year)	_____ $12	_____ $23	_____ $33
Sugar and Sweetener (4 per year)	_____ $12	_____ $23	_____ $33
Tobacco (4 per year)	_____ $12	_____ $23	_____ $33
U.S. Agricultural Trade Update (monthly)	_____ $15	_____ $29	_____ $42
Vegetables and Specialties (3 per year)	_____ $12	_____ $23	_____ $33
Wheat (4 per year)	_____ $12	_____ $23	_____ $33
Agriculture and Trade Reports (5 per year) Supplement your subscription to *World Agriculture* by subscribing to these five annuals: *Western Europe, Pacific Rim, Developing Economies, China*, and *USSR*.	_____ $12	_____ $23	_____ $33

For *fastest* service, call our order desk toll free: 1-800-999-6779 (8:30-5:00 ET in the U.S. and Canada; other areas please call 301-725-7937)

- Use purchase orders, checks drawn on U.S. banks, cashier's checks, or international money orders.
- ***Make payable to ERS-NASS.***
- Add 25 percent for shipments to foreign addresses (includes Canada).

☐ Bill me. ☐ Enclosed is $________.

Credit Card Orders:

☐ MasterCard ☐ VISA Total charges $__________.

Credit card number: ________________ **Expiration date:** Month / Year ______

Name ____________________

Organization ____________________

Address ____________________

City, State, Zip ____________________

Daytime phone (_______)____________________

Complete both sides of this order form and mail to:

ERS-NASS
P.O. Box 1608
Rockville, MD 20849-1608

Get these timely reports from USDA's Economic Research Service

These periodicals bring you the latest information on food, the farm, and rural America to help you keep your expertise up-to-date. Order these periodicals to get the latest facts, figures, trends, and issues from ERS.

Agricultural Outlook. Presents USDA's farm income and food price forecasts. Emphasizes the short-term outlook, but also presents long-term analyses of issues ranging from international trade to U.S. land use and availability. Packed with more than 50 pages of charts, tables, and text that provide timely and useful information.

Economic Indicators of the Farm Sector. Updates economic trends in U.S. agriculture. Each issue explores a different aspect of income and expenses: national and State financial summaries, production and efficiency statistics, and costs of production for livestock and dairy and for major field crops.

Farmline. Concise, fact-filled articles focus on economic conditions facing farmers, how the agricultural environment is changing, and the causes and consequences of those changes for farm and rural people. Synthesizes farm economic information with charts and statistics.

Food Review. Offers the latest developments in food prices, product safety, nutrition programs, consumption patterns, and marketing.

Foreign Agricultural Trade of the United States. Every 2 months brings you quantity and value of U.S. farm exports and imports, plus price trends. Subscription includes two big 300-page supplements containing data for the previous fiscal or calendar year. A must for traders!

Journal of Agricultural Economics Research. Technical research in agricultural economics, including econometric models and statistics on methods employed and results of USDA economic research.

Rural Conditions and Trends. Tracks rural events: macroeonomic conditions, employment and underemployment, industrial structure, earnings and income, poverty and population.

Rural Development Perspectives. Crisp, nontechnical articles on the results of the most recent and the most relevant research on rural areas and small towns and what those results mean.

World Agriculture. Deals with worldwide developments in agricultural markets and trade. Updates current conditions and recent economic changes, and highlights significant trends—all with an emphasis on implications for global and U.S. agriculture.

☐ Check here for a **free** subscription to *Reports*, a quarterly catalog describing the latest ERS research reports. It's designed to help you keep up-to-date in all areas related to food, the farm, the rural economy, foreign trade, and the environment.

	1 year	2 years	3 years
Agricultural Outlook (11 per year)	_____ $26	_____ $51	_____ $75
Economic Indicators of the Farm Sector (5 per year)	_____ $14	_____ $27	_____ $39
Farmline (11 per year)	_____ $12	_____ $23	_____ $33
Food Review (4 per year)	_____ $11	_____ $21	_____ $30
Foreign Agricultural Trade of the United States (8 per year)	_____ $25	_____ $49	_____ $72
Journal of Agricultural Economics Research (4 per year)	_____ $8	_____ $15	_____ $21
Rural Conditions and Trends (4 per year)	_____ $14	_____ $27	_____ $39
Rural Development Perspectives (3 per year)	_____ $9	_____ $17	_____ $24
World Agriculture (4 per year)	_____ $21	_____ $41	_____ $60

Complete both sides of this order form.
Single copies of all periodicals available for $8.00 each.

py

UNITED STATES DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
WASHINGTON, DC 20005-4788